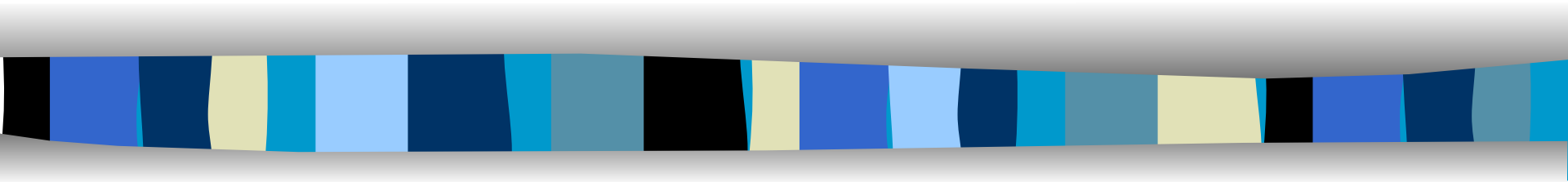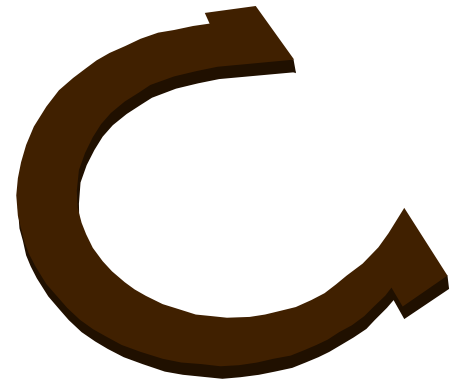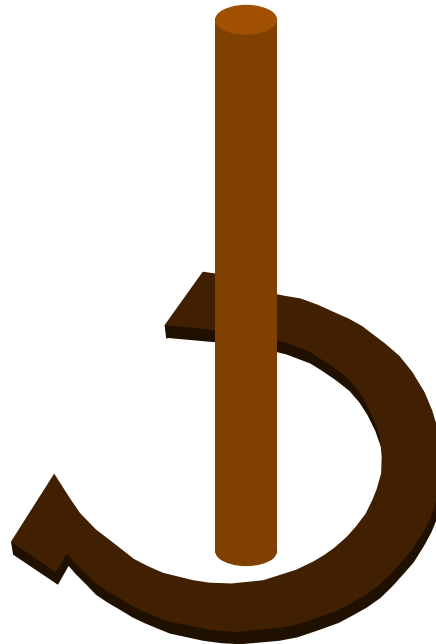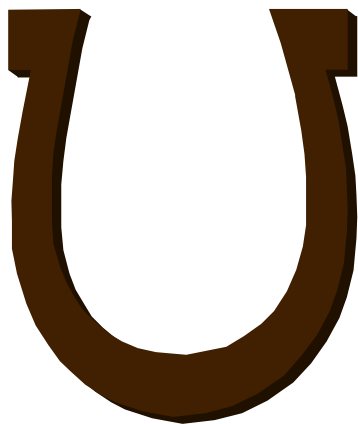# Production Estimation

Overview

- To teach you how to accurately estimate an equipment oriented mission by using given estimation production formulas and procedures.

Learning Objectives

- Terminal Learning Objective
- Enabling Learning Objective

Method and Media

- Lecture, demonstration, and practical application Methods

- Computer Generated Slides

4

Evaluation

- Practical applications using each Production Estimation Formula.
- **<u>Open book exam!</u>**

Safety/Cease Training

- Safety

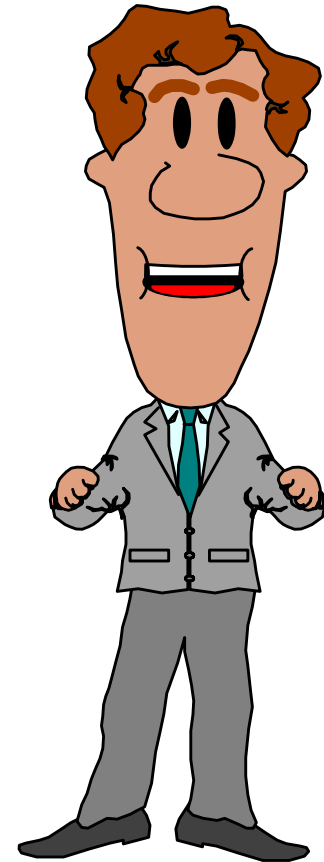- Cease Training

ANY QUESTIONS?

Estimating

- The art of determining the size of the job, labor, equipment needed to perform the job and quantities of materials.

- To do any type of estimation, you need to know some

Soil States

- Soil is found in three states.
  - Sometimes it is necessary to convert from one volume to another.
  - To do this we use table #1-1.

Loose

Bank

Compacted
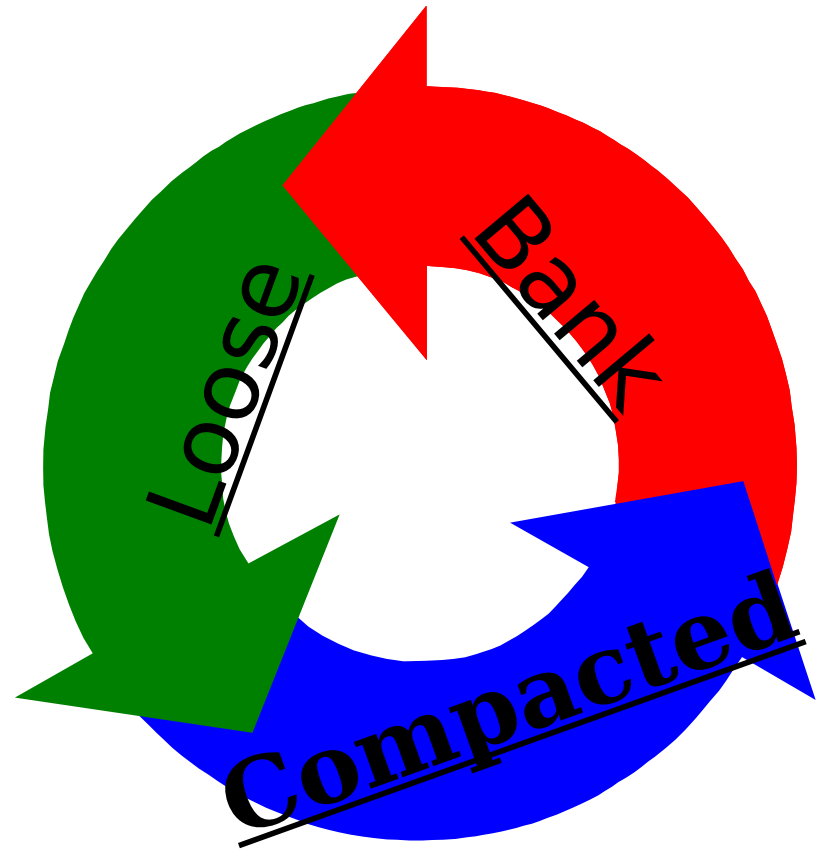
Bank State

Any soil that has not been disturbed from its natural state for at least ten years.
- This is also known as Bank Cubic Yards (BCY).

1.0 CUBIC YARD IN
NATURAL CONDITION
(IN PLACE)

=Bank State

EXAMPLE FOR THE VARIOUS STATES

Loose State

Any soil that has been disturbed.

- Note: Soil is always in a loose state when hauled, worked or stockpiled.
- This is also known as Loose Cubic Yards (LCY).

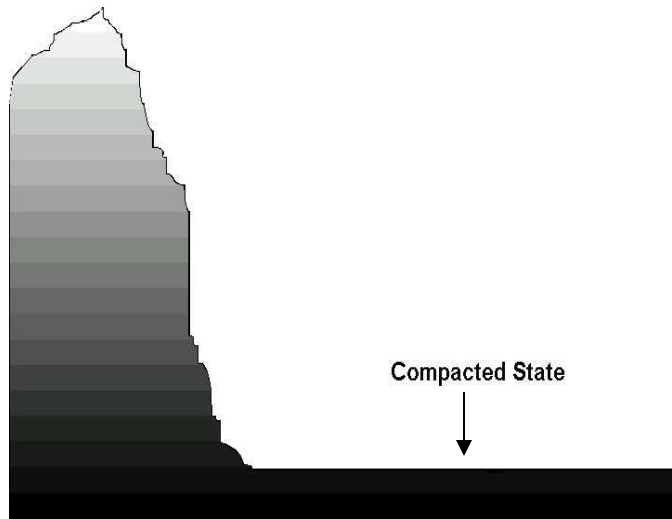1.25 CUBIC YARDS
AFTER DIGGING
(LOOSE)
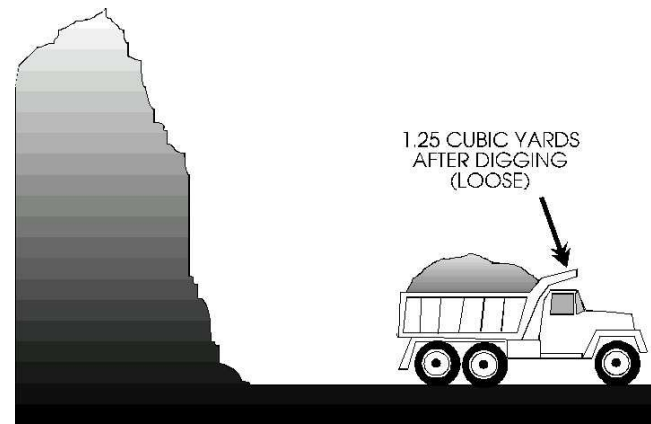
EXAMPLE FOR THE VARIOUS STATES

Compacted State

Any soil that has been compacted by artificial means.

– This is also known as Compacted Cubic Yards (CCY).

Compacted State

EXAMPLE FOR THE VARIOUS STATES

Table #1-1 Soil Conversion Factors

Soil	Converted From:	Bank	Loose	Compacted
Sand or Gravel	Bank	*	1.11	.95
	Loose	.90	*	.86
	Compacted	1.05	1.17	*
Loam	Bank	*	1.25	.90
	Loose	.80	*	.72
	Compacted	1.11	1.39	*
Clay	Bank	*	1.43	.90
	Loose	.70	*	.63
	Compacted	1.11	1.59	*
Rock (Blasted)	Bank	*	1.50	1.30
	Loose	.67	*	.87
	Compacted	.77	1.15	*
Coral Comparable To Limestone	Bank	*	1.50	1.30
	Loose	.67	*	.87
	Compacted	.77	1.15	*

13

Example

- If we needed to make a road that is 1,500' long with a 3" lift of gravel and 24' wide, it would be necessary to compute the volume first in compacted cubic yards and then convert it to a loose state.

- This determines how much material our haul units would have to move.

- This is done by multiplying the volume of the compacted material by a conversion factor.

Solution

3" ÷ 12" = .25'

1500' (L) x .25' (H) x 24' (W) =

9000' ÷ 27 = 333.33 or 334 CCY

334 CCY

x1.17 Conversion Factor

390.78 or 391 LCY

Note: Round up to the next full cubic yard.
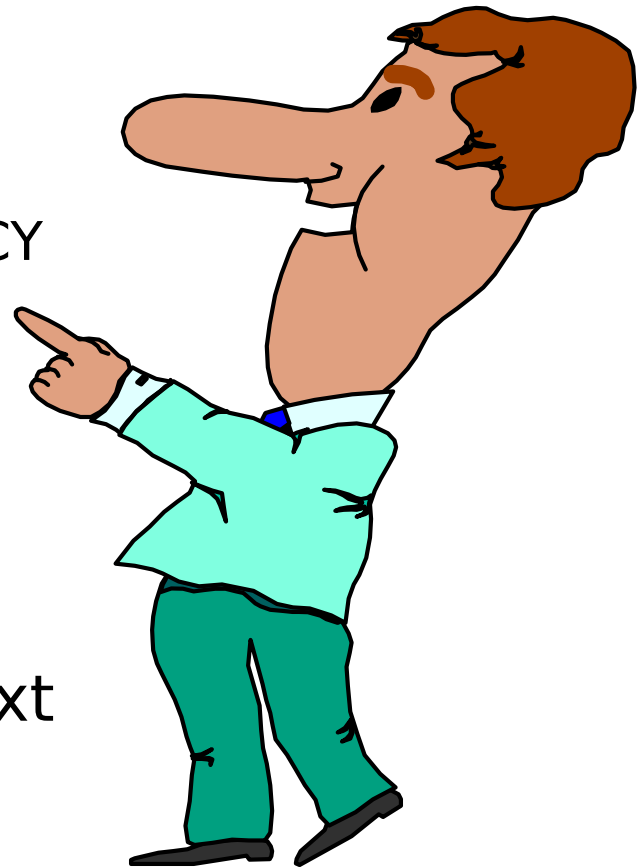
What Have You Learned?

Problem #1

Your crew is tasked to dig a trench which is 300' long, 9' wide, and 6' deep.

– Earth loam, dry and the soil has been undisturbed for more than 10 years.

– Using a 420 DV

– How many loose cubic yards of soil will you remove?

Solution

$$\frac{300' \times 9' \times 6'}{27} = 600 \text{ BCY}$$

$$600 \text{ BCY} \times 1.25 = 750 \text{ LCY}$$

What Have You Learned?

- Problem #2
- In the previous problem you removed ___ LCY of soil.
- However you requirement for a road you are working on is 16,600 CCY.
- Will you have enough soil to do the road?
- If yes, how much

Solution

750 LCY x .72 = 540 CCY

16,600 CCY

-     540 CCY

16,060 CCY under

Production Time

- Loose Cubic Yards/Hour (LCYPH)

- Each piece of equipment has its own production formula.

- Bank Cubic Yards/Hour (BCYPH)

- Basic Formulas

- Cubic Yards Per Hour (CYPH)

- Compacted Cubic Yards/Hour (CCYPH)

18

Cubic Yards Per Day (CYPD)

- Total cubic yards moved per hour multiplied by the total hours worked per day.

- Example:

  100 CYPH x 8 hr work/day = 800 CYPD

  Note: Round down CYPD

Production Days

- Total requirement of material needed divided by the total CYPD moved.

- Example:

  16,600 req CY $\div$ 800 CYPD =

  20.75 or 21 days

  Note: Round up days to next full day.

What Have You Learned?

- Problem #3
  - You are moving 150 LCYPH
  - Working 5 hours per day.
  - The requirement to be moved is 17,000 LCY.
  - LCYPD?
  - Total Days?

Solution

150 LCYPH x 5 Hrs/day = 750 LCYPD

17,000 Req LCY ÷ 750 LCYPD =
22.67 or 23 days

What Have You Learned?

- Problem #4
  - You are moving 250 LCYPH
  - Working 8 Hrs/day.
  - The requirement to be move is 18,000 LCY.
  - LCYPD?
  - Total Days?

Solution

250 LCYPH x 8 Hrs/day = 2,000 LCYPD

18,000 Req LCY ÷ 2000 LCYPD = 9 days

■Questions

Scrapers

– Designed for loading, hauling and dumping on long haul earthmoving operations.

an
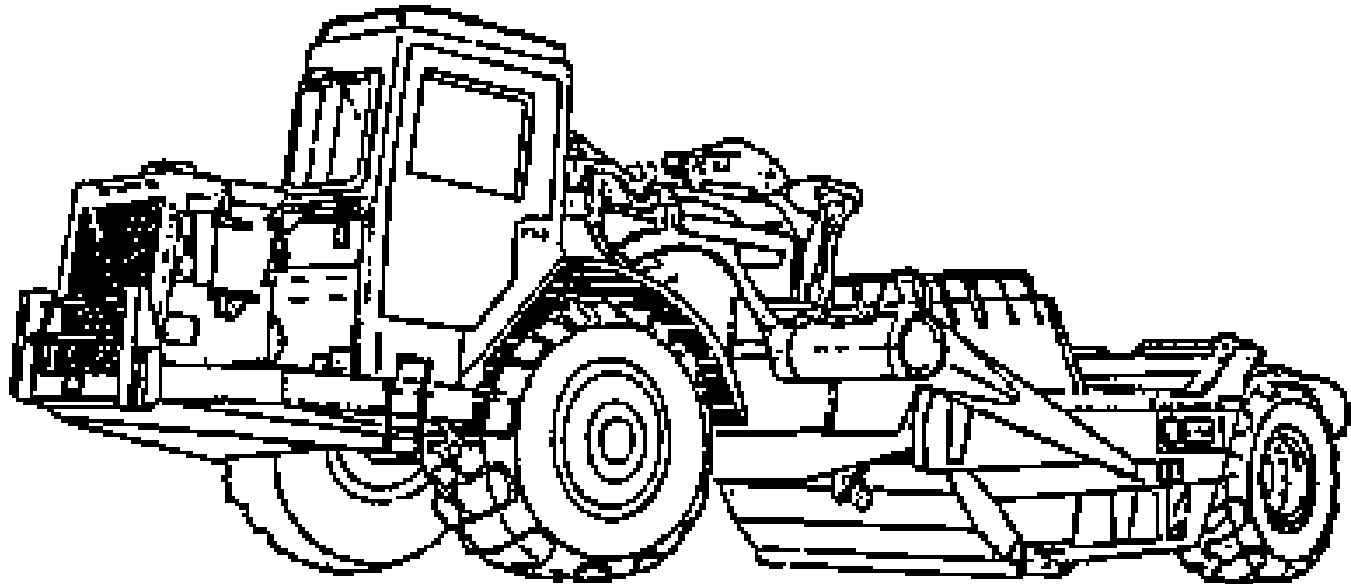
– The ejector is the rear wall of the bowl. It is moved back to load, and forward to discharge materials.

26

Scraper Uses

- Scrapers serve the primary purpose of loading and hauling material.
  - The distinct advantage of the scraper, is the ability to load, haul, and spread in one continuous cycle.
  - Capacity is measured in heaped and struck capacity.
  - Capable of working alone for leveling operations, but is supplemented with push-tractors for cut and fill operations.

Classification

- Classified according to load capacity and rated load.
  - A heap load is the maximum load of the machine.
  - A struck load is the minimum effective load.

Characteristics

- – Wheeled vehicle characterized by a tractor and a scraper.
- – Prime movers in cut and fill operations and in bringing elevations to rough, final grades.
- – Open bowl design, they can be loaded from above.
- – 3 types of cutting edges:
- – Straight, Curved, and the 3 piece cutting edge.
- – **The 621B has a rated load weight of 48,000 lbs.**

Operation

- Hydraulically operated and powered by a tractor.
- Most efficient during downhill loading.
- Other methods of production include straddle loading and pump loading.
- All loading should be accomplished with a pusher, within (1) minute, and within (100) feet of travel.

Types Of Loads

■ Struck load:
  – Loaded with soil until the material is approximately even with the top of the side boards.
  – The capacity of the 621B Scraper, when

■ Heap load:
  – Loaded with soil when the material is overflowing the side boards.
  – The capacity of the 621B Scraper, when heap loaded, is 31
  18 Loose Cubic

Actual Load Size (ALS)

- Actual load size (ALS) will vary considerably, being somewhere between struck & heap due to variables such as:
  - Soil weight
  - Moisture Content
  - Manner in which scraper is being loaded.

Scraper Production

- Are there any questions?

- There are 15 steps involved with scraper production estimations.

Questions?

Step 1 Scraper Production: Soil Weight

- Soil weight is used in all production.

- To determine the actual soil weight (ASW) per cubic yard, start by taking the soil weight from table #2-2.
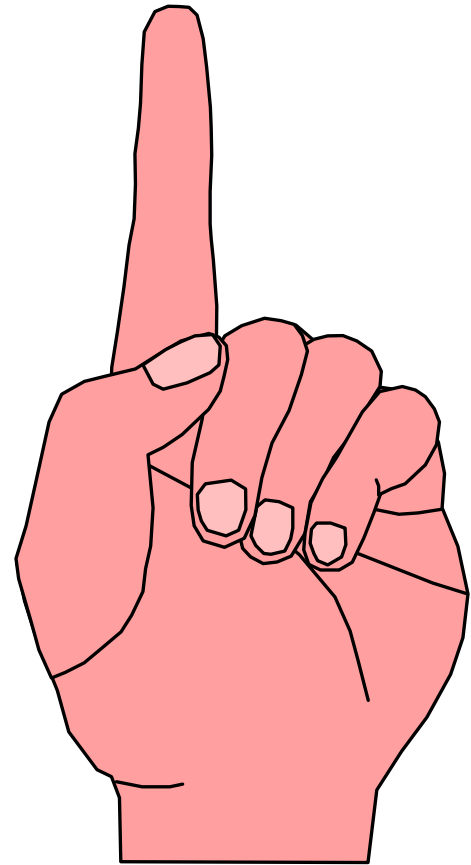
Table #2-2 Approximate Weight of Soil

PER CUBIC YARD

Type Of Soil	Pounds Per (CY)	Type Of Soil	Pounds Per (CY)
Cinders	1,200 lbs.	Limestone	2,500 lbs.
Clay, Dry	2,000 lbs.	Sandstone	2,200 lbs.
Clay, Wet	3,000 lbs.	Sand, Dry	2,900 lbs.
Clay, Gravel	2,700 lbs.	Sand, Wet	3,100 lbs.
Gravel, Dry	3,000 lbs.	Shale & Soft Rock	2,700 lbs.
Gravel, Wet	3,100 lbs.	Slag, Bank	1,940 lbs.
Earth Loam, Dry	2,200 lbs.	Slate	

Moisture Content

- Moisture weight in the soil.
  - Although table #2-2 shows some soils with moisture, it may be necessary to get an exact moisture content to determine soil weight.
  - The moisture will

- Soil analysis personnel are trained to determine the moisture content, and the weight of this moisture must be calculated and added to the

Actual Soil Weight (ASW)

- For classroom purposes:
  - *If you are given a wet soil*, take the weight of the wet soil off table #2-2.
  - *If you are not given either wet or dry condition*, take the weight of dry soil off table #2-2.
  - *If you are given a wet soil and a moisture content*, take the weight of dry soil and multiply the moisture content.
- *Never round off ASW*

Actual Soil Weight (ASW)

- Method used to determine ASW.
- Example:
- Earth Loam with a 7% moisture content.
  - Earth loam weighs 2,200 lbs/cubic yard.
  - Multiply 2,200 by 1.07 to get the moisture weight of

- The initial moisture content is 7% of the original weight.
  - Therefore, the actual soil weight is 107% of the original weight.
  - Convert the percentage to a decimal.
  - Multiply the

39

Scraper Production Step #1

- **Example.**
- **Actual Soil Weight (ASW).**
- Remember never round off ASW.
- Earth Loam weighs 2,200 lbs./CY. With 7% moisture content.

    2,200 x 1.07 = 2,354 ASW

Try A Few

- Figure out the Actual Soil Weight (ASW) of the following:
  - Wet clay, with 14% Moisture.
  - Wet sand, with 17% moisture.
  - Soft coral, with 2% moisture.
  - Earth loam
  - Clay & gravel, with 18% moisture.
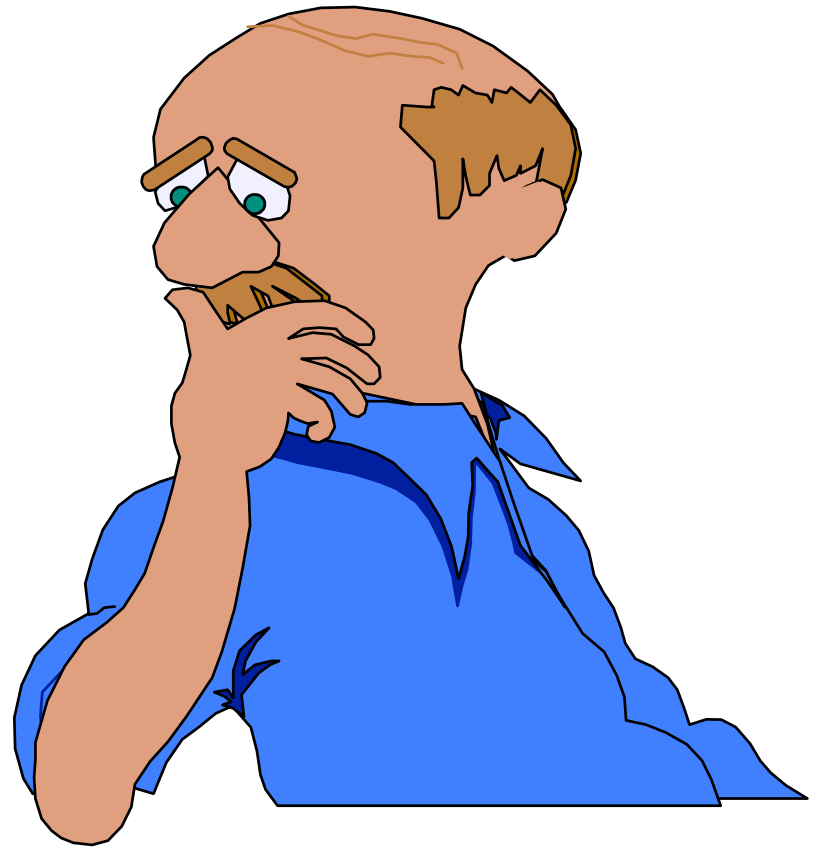
Solutions

2,000 x 1.14 = 2,280 ASW

2,900 x 1.17 = 3,393 ASW

2,030 x 1.02 = 2,070.60 ASW

2,200 ASW

2,700 x 1.18 = 3,186 ASW

42
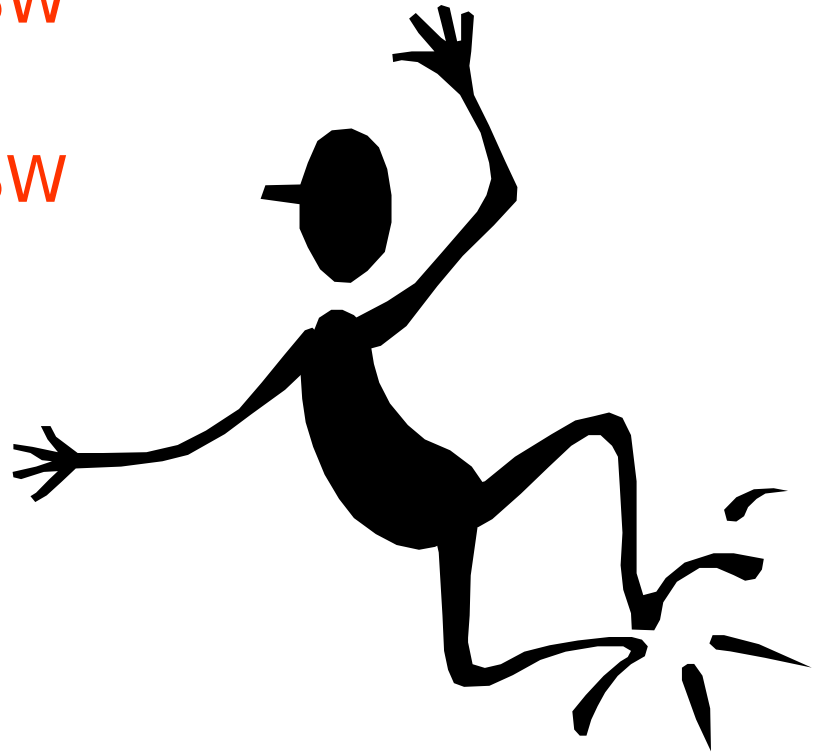
Scraper Production Step #2

Cubic Yards of a Load.

– You have to determine the maximum cubic yards you can haul without exceeding 48,000 lbs. (max load) or 18 cubic yards (max capacity).

- Example:
  48,000 lbs. (rated capacity)

  2,354 lbs. (Actual Soil Weight)
  20.39 CY No more than 18 CY

- If the resulting figure is less than 18, use that entire number as it appears on the calculator in step #3.

- If Push or Self Loading, this is your Actual Load Size (ALS) - go to Step #5

43

Scraper Production Step #3

Buckets Loaded.

- **Buckets loaded** must be a whole number.

- Divide cubic yards of a load by the bucket size.

Example:

<u>18</u> Cubic Yards

2.5 Cubic Yards (bucket size from table #3-2)

7.2 buckets or 7 bucket loads

Note: Round down to whole buckets loaded.

44

Bucket Sizes Table #3-2

Type of Equipment	Bucket size
Tram 624KR	2½ or 2.5 CY
MC1155E	1¾ or 1.75 CY
ATC CLAMSHELL	1¼ or 1.25 CY
420D Front Bucket	1 or 1.25
420D Backhoe Bucket	¼ or .25

Scraper Production Step #4

- **Actual Load Size.**
  - The true amount of soil in haul unit.
  - Number of buckets multiplied by the bucket size.

- Example:

  7   # of Buckets

  x 2.5   TRAM Bucket Size

  17.5 cy   Actual Load Size (ALS)

- Note: Never round off ALS.

Scraper Production Step #5

Load Weight (LW).

- Multiply your ASW by your ALS.
- Keep your load weight under 48,000 lbs.
- Table #2-2 shows the weight of cinders as 1200 lbs./LCY.
- A struck load would weigh 16,800 lbs., while the heap load would weigh 21,600 lbs..
- These weights would be easily hauled, but it is a different story with other materials.
- Take a look at Earth Loam, wet for instance:

3,200   weight of Earth Loam, wet/CY   3,200

x 14   LCY Struck   x 18 LCY Heaped

44,800 lbs. Struck Loaded   57,600 lbs.

Example

- Each cubic yard weighs 2,354 lbs. (step #1), and you are hauling 17.5 cubic yards.

$$2,354$$
$$\times 17.5 \text{ ALS}$$

41,195 load weight (LW)

- Note: Never round off load weight.

Scraper Production Step #6

- **Short Tons**
  - First determine the gross weight of the vehicle with load.
  - Divide the gross weight by 2,000 lbs. (the weight of one ton).
- Example:

41,195 LW (step #5)

+66,590 Tractor weight

CLEAR CALCULATOR

107,785 Gross weight

÷ 2,000 Weight of 1 ton

53.89 Short tons (ST)

What Have You Learned?

■ Problem #1
- – Figure the ASW of Gravel with a 12% moisture content.

■ Solution:

3,000   Weight of dry gravel

x1.12   Moisture content

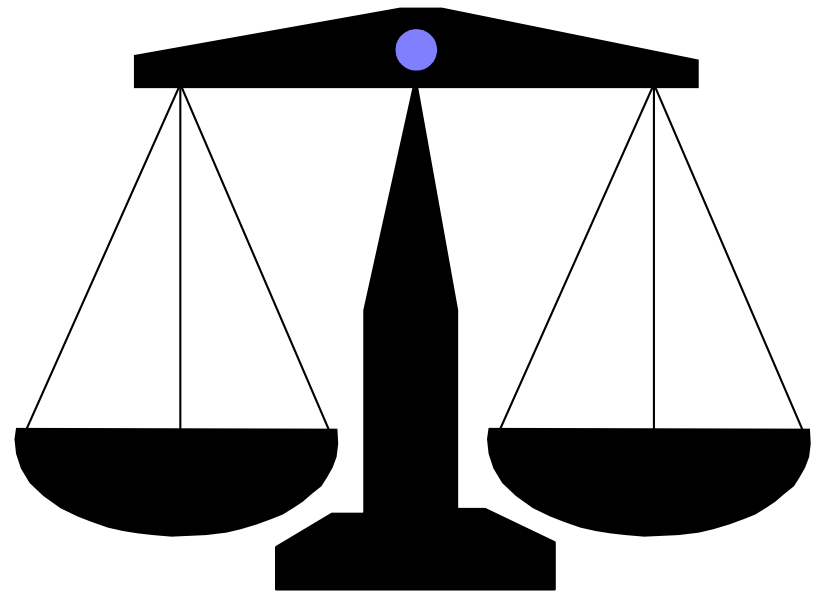3,360 lbs. ASW

What Have You Learned?

- **_Problem #2_**
  - When hauling this gravel in a 621B loaded with a TRAM 624KR, what would the **load weight** be?

What Have You Learned?

■ Solution:

	5 # buckets loaded
48,000 Rated Capacity	x2.5 Bucket size
÷3,360 ASW	12.50 ALS
14.29 CY of load	x3,360 ASW
÷ 2.5 Bucket size	42,000 LW

What Have You Learned?

- ***Problem #3***
  - If the 621B has a load weight of 46,590 lbs., what would your **short tons** be?

- Solution:

$$46,590 \quad \text{LW}$$

$$+66,590 \quad \text{Tractor weight}$$

113,180 Gross weight

$$\div \ 2,000 \quad \text{1 ton}$$

56.59 ST

Scraper Production
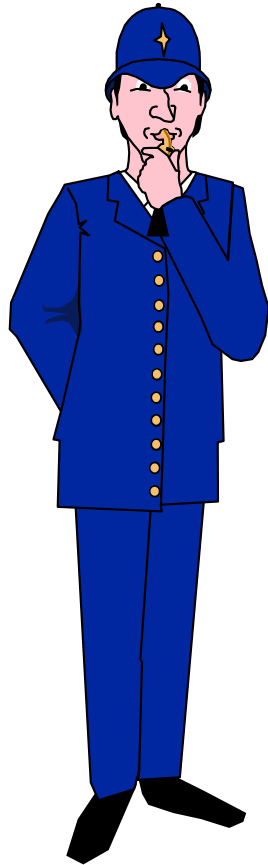
- Take a break!

Scraper Production Step #7

Rolling Resistance

- The resistance of movement to wheeled vehicles over a haul surface caused by irregularities in the surface such as compacting and displacement of

- Rolling resistance is measured by the rim pull in pounds per **short ton** required to overcome resistance.

- This resistance effects the cycle time.

Scraper Production Step #7

To do this multiply **short tons** (from step #6) by the **rolling resistance factor** (RRF) found in table #4-2).

The resulting answer will be your *rolling resistance (RR).*

Table #4-2 Rolling Resistance Factors

Hard, Smooth, Stabilized roadway without penetration under load **(CONCRETE OR BLACKTOP)**	40 lbs. a ton
Firm, Smooth-Rolling roadway flexing slightly under load 1" penetration **(GRAVEL TOPPED ROAD)**	65 lbs. a ton
Rutted Dirt roadway, flexing considerably under load 2"-3" penetration **(SOFT CLAY ROAD)**	100 lbs. a ton
Rutted Dirt roadway, no stabilization under load 4"-6" penetration **(SOFT CLAY ROAD)**	150 lbs. a ton
No stabilization 7" or greater penetration **(SOFT, MUDDY, RUTTED ROADWAY, OR IN SAND)**	400 lbs. a ton

Example

Determine the rolling resistance for a 621B scraper traveling **over firm, smooth-rolling roadway flexing slightly under load 1" penetration.**

■ 53.89   ST (from step #6)

x 65   RRF (from table #4-2)

3502.85 or 3503   RR

■ Note: Round Off Rule

– Round up 5 or greater, round down 4 or less for RR.

57

What Have You Learned?

- Problem #1
  - Figure the Rolling Resistance for the following situation.
  - 621B Scraper
  - Struck loaded (self loaded)
  - Hard pan
  - Rutted, dirt

Step #1

3,100 ASW

Step #2

N/A

Step #3

N/A

Step #4

N/A

What Have You Learned?

- Step #5 / #7

35,100   ASTW
x 100   ARLSF
43,400   LRWR

- Step #6

43,400   LW

+66,590   TR
WT

109,990   GW

÷ 2,000   1

59

What Have You Learned?

- ***Problem #2***
- Figure rolling resistance for the following situation.
  - 621B scraper
  - Loaded with a Tram (2½ CY bucket)
  - Trap rock
  - Hard, smooth

- Step #1
  - 3,500   ASW
- Step #2
  - 48,000   Rated Capacity
  - ÷3,500   ASW
  - 13.71   CY of a load
- Step #3
  - 13.71   CY of a load

What Have You Learned?

■ Step #4

    5   Buckets loaded

   x2.5   Bucket size

   12.50 ALS

■ Step #5

   3,500   ASW

   x12.50   ALS

   43,750 LW

■ Step #6

   437250   LW

 + 66,590 TR

WT

   110,340   GW

÷ 2,000   1 ST

   55.17   ST

■ Step #7

  55.17

ST

Scraper Production Step #8

Grade Resistance (GR) or Grade Assistance (GA)

- Rules of thumb generally accepted as reliable measures of the effect of grades are as follows:
  - Grade resistance effects the cycle time by slowing the scraper.
  - Grade resistance or Grade assistance is the increase, or decrease, in the amount of
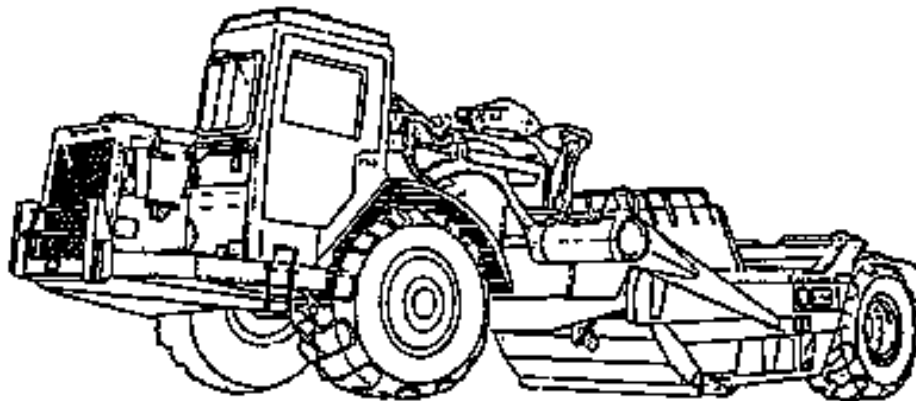
62

Scraper Production Step #8

Each 1% of **uphill** grade increases the resistance by 20 lbs. Per short ton pull of gross vehicle weight.

Formula:

Short tons x 20 (constant) x % of grade = **Grade resistance or assistance**.

Example

The total weight of the loaded scraper on the haul is 107,785 lbs. (from step #6)

- Calculate the grade resistance factor for climbing a (+2) uphill grade.

Example Solution

$\underline{53.89}$ x $\underline{20}$ x $\underline{2}$ = $\underline{2155.6 \text{ or } 2156}$

ST   x 20   x % grade = grade resistance (GR)

Note:

Round up 5 or greater, round down 4 or less
(GR
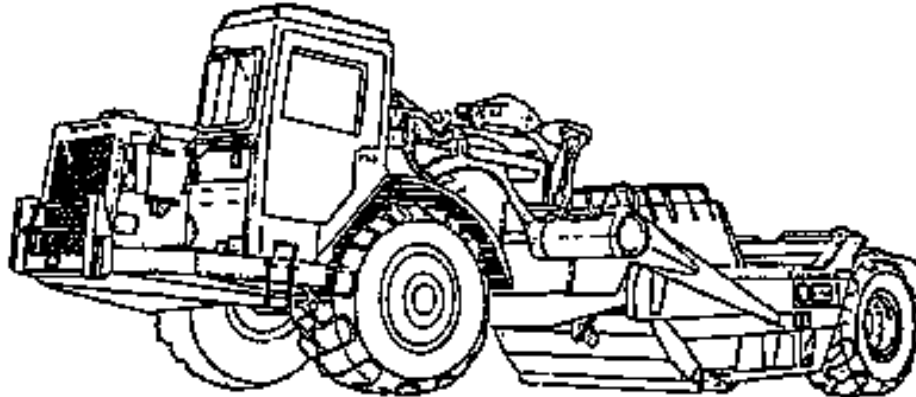
Scraper Production Step #8

- Each 1% of **downhill** grade decreases the amount of pull required by 20 lbs. Per short ton of gross vehicle weight.
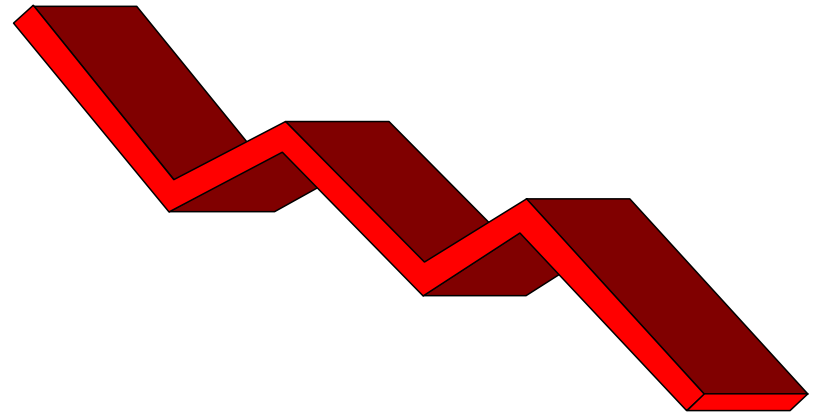
Example

- For the return, the tractor is empty so the total weight is 66,590 lbs.
  - Calculate the grade assistance factor for (-2) downhill grade.
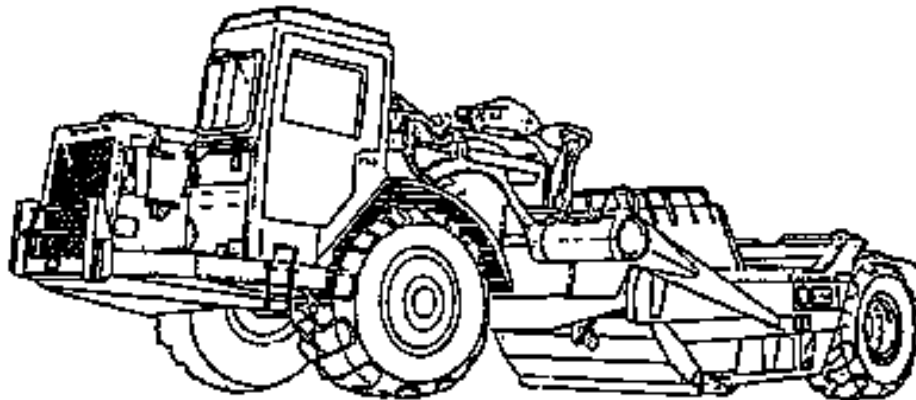
Example Solution

33.30 x **20** x **-2** = **-1,332**

ST empty x 20 x % of grade = Grade Assistance (GA)

Note:

– **Rou** **or less.**
(GR
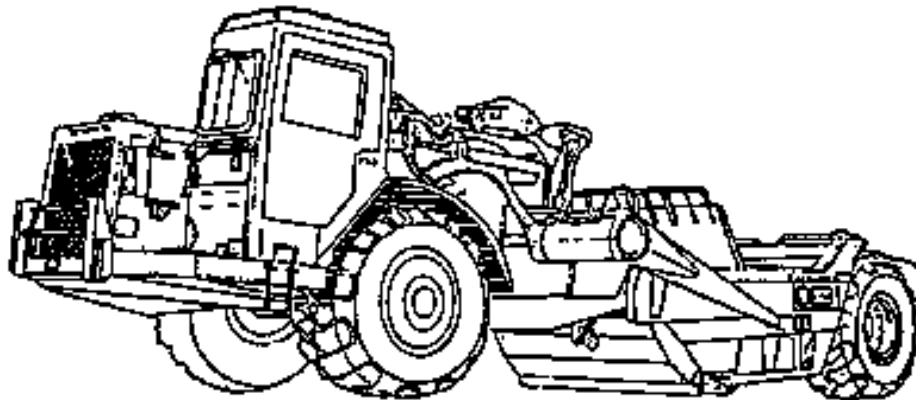
What Have You Learned?

- ***Problem #1*** Determine **Grade Resistance** for a 621B with the following factors:
  - Struck load
  - Sand

  7% initial moisture

  3% Uphill grade
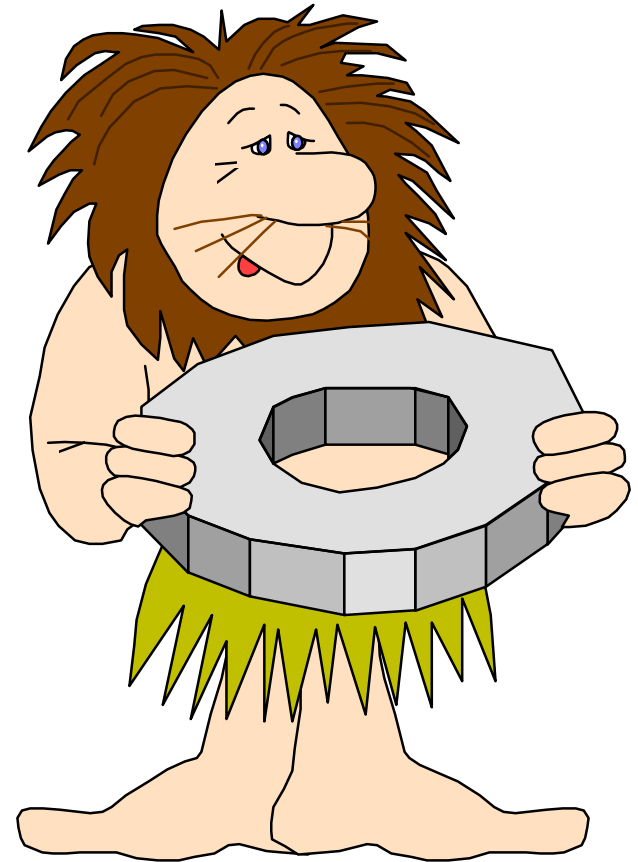
What Have You Learned?

- ## Step #1

  $\begin{array}{ll} 2,900 & \text{Soil WT} \\ \times\ 1.07 & \text{Moisture} \\ \hline 3,103 & \text{ASW} \end{array}$

- ## Step #2

  N/A

- ## Step #3

  N/A

- ## Step #4

- ## Step #5

  $\begin{array}{ll} 3,103 & \text{ASW} \\ \times\ \ \ \ 14 & \text{ALS} \\ \hline 43,442 & \text{LW} \end{array}$

- ## Step #6

  $\begin{array}{ll} 43,442 & \text{LW} \\ +66,590 & \text{TR WT} \\ \hline 110,032 & \text{GW} \\ \div\ \ 2,000 & \text{1 ST} \\ \hline 55.02 & \text{ST} \end{array}$

What Have You Learned?

Step #7
 N/A

Step #8

  55.02   ST

  x   20
  Constant

  x   3   % of
  grade

  3,301.20 or 3,301
  GR

What Have You Learned?

Problem #2

– Determine **rolling and grade resistance** for a 621B on the haul with the following factors:

– Heap load

– Sandstone

– Rutted, dirt roadway, no stabilization under load, 4"–6"
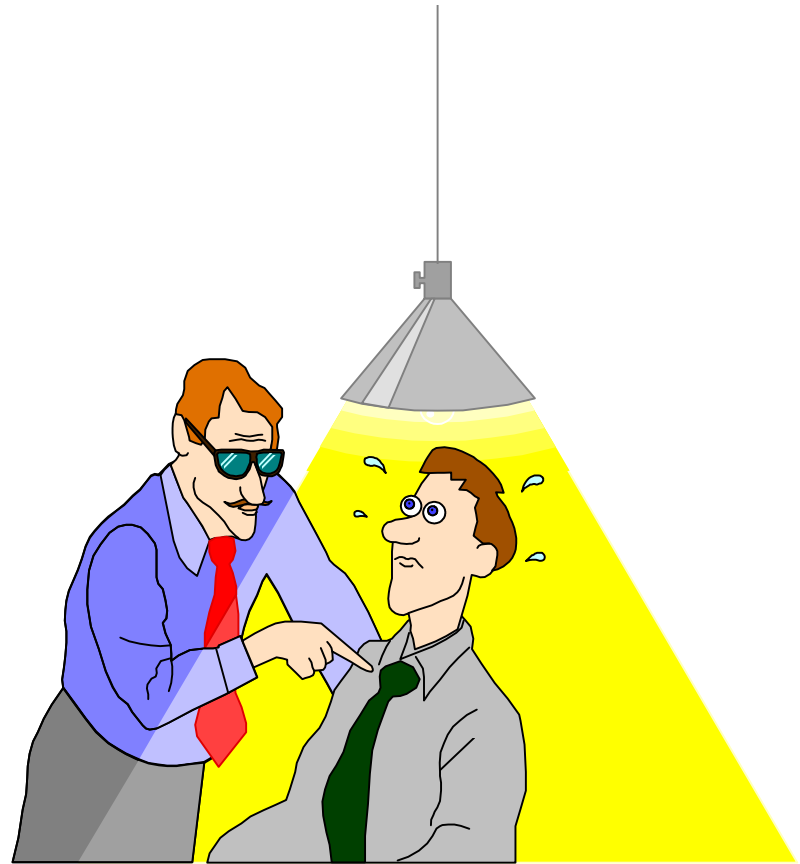
What Have You Learned?

- Step #1
  2,200 ASW
- Step #2
  N/A
- Step #3
  N/A
- Step #4
  N/A

- Step #5

	2,200	ASW
x	18	ALS
	39,600	LW

- Step #6

	39,600	LW
+	66,590	TR WT
	106,190	GW
÷	2,000	1 ST
	53.10	ST

73

What Have You Learned?

- Step #7

53.10	ST
x 150	RRF
7,965	RR

- Step #8

53.10	ST
x 20	Constant
x 6	% of grade
6,372	GR
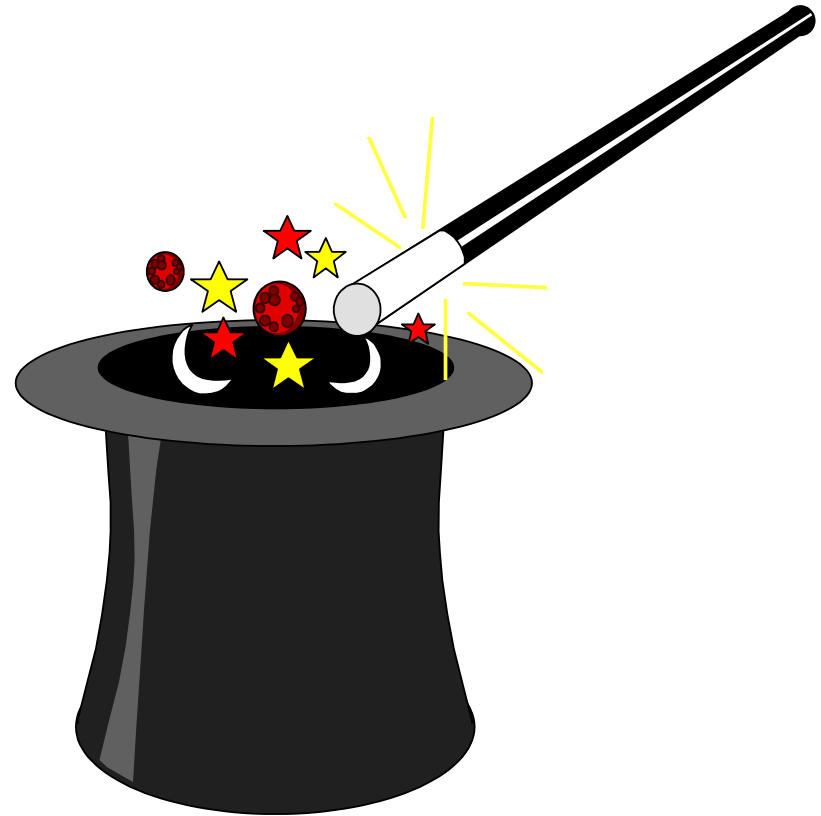
Scraper Production

- Take a break!

Scraper Production Step #9

Required Pounds Of Pull (REQPP)

– The total power required to move a unit.

– We can find our **REQPP** by adding **GR** with **RR** from uphill, or Subtract **GA** from **RR** for downhill.

– When on level ground, your **RR** is your **REQPP**.

Example 1

- When traveling **uphill** a vehicle must overcome both rolling resistance and grade resistance.

3,503   RR

+2156   (+GR)

5,659 REQPP Using table #5-2, you can see that the scraper will not give you enough Rim Pounds Pull(RPP) in 8th or 7th gear, but 6th gear you have enough RPP. **The travel speed is 14 Mph.**

Table #5-2 **Power Characteristics of 621B Scraper**

Available RPP	35,062	23,375	16,187	13,148	9,146	6,657	5,008	3,393
Gear	1st	2nd	3rd	4th	5th	6th	7th	8th
TS Speed Mph	2	4	6	8	11	14	19	26

Scraper Production Step #9

Note:

- – If your TM doesn't have the table, you can use the following formula to get your **RPP.**

$$\frac{375 \ x \ \text{Engine HP} \ x \ 80\% \ \text{Efficiency}}{\text{travel speed in mph.}} = $$

Rim Pounds Pull (RPP)

Example 2

When traveling **downhill** a vehicle must overcome rolling resistance less grade assistance.

    2,165 RR

    <u>-1,332</u> GA

      833 REQPP

- Using table #5-2, we see that the scraper will give you enough RPP in 8th gear.
- **The travel speed is 26 mph.**

When traveling over level terrain, a vehicle must overcome rolling resistance only.

    3,503 RR = 3,503 REQPP

- Using table #5-2, we see that the scraper will give you enough RPP in 7th gear.

79

- **The travel**

What Have You Learned?

Problem #1

– Determine **travel speed** with the following factors:

– 621B scraper

– Struck Load

– Earth loam

10% initial moisture

– Hard, smooth roadway with no penetration under load.

4% downhill grade.

What Have You Learned?

- Step #1

  2,200 Dry soil WT

  x 1.10 Moisture

  2,420   ASW

- Step #2
  - N/A
- Step #3
  - N/A

- Step #5

  2,420   ASW

  x   14   ALS

  33,880   LW

- Step #6

  33,880 LW

  + 66,590 TR WT

  100,470 GW

  ÷ 2,000   1 ST

  50.24   ST

What Have You Learned?

- Step #7

50.24	ST
x 40	RRF
2,009.6 or 2,010	RR

- Step #8

50.24	ST
x 20	constant
x -4	%
grade

- Step #9

2,010	RR
-4,019	GA
-2,009	REQPP
8th gear 26 mph	
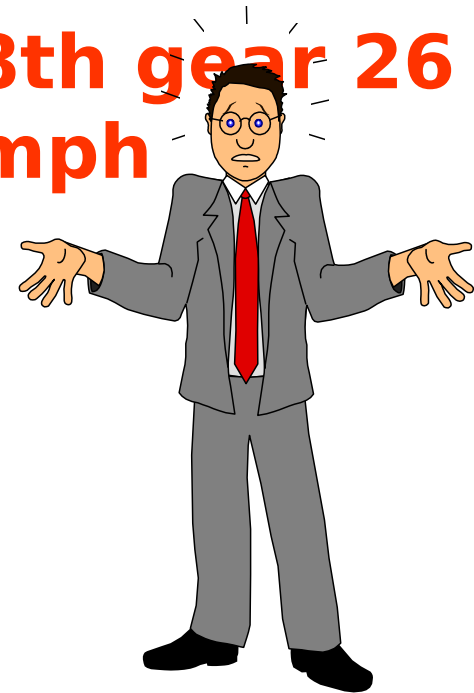
What Have You Learned?

Problem #2
- Determine the travel speed with the following factors:
- 621B Scraper
- Struck load
- Clay and gravel

3% initial moisture
- Rutted, dirt roadway, no stabilization under load, 4"-6" penetration.

6% uphill grade.

What Have You Learned?

- Step #1

  2,700   Dry soil WT

  x1.03   Moisture

  2,781   ASW

- Step #2

  – N/A

- Step #3

  – N/A

- Step #5

  2,781   ASW

  x   14   ALS

  38,934   LW

- Step #6

  38,934   LW

  + 66,590 TR WT

  105,524   GW

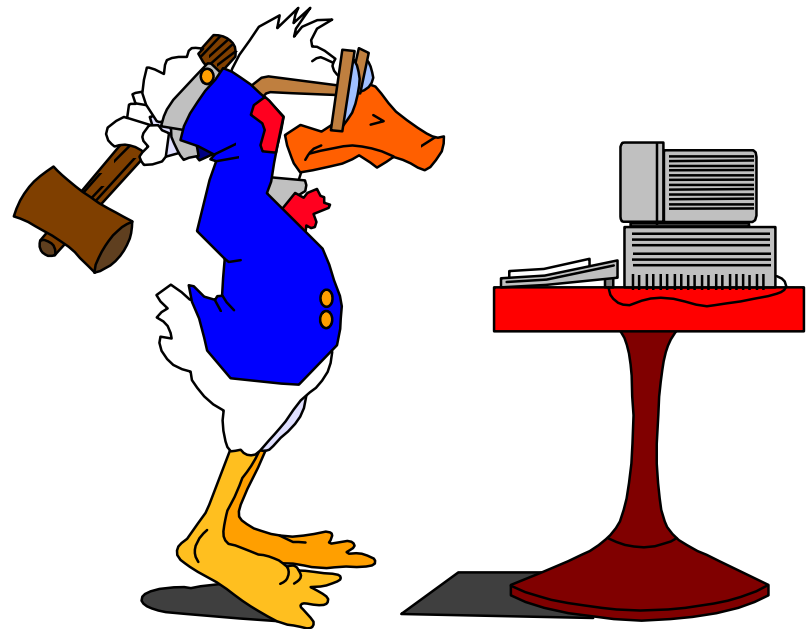 ÷ 2,000   1 ST

  52.76   ST

What Have You Learned?

- Step #9

  52.76 14 STRR

  x 16,531 RRGR

  79,245 RBQPP

  3rd gear 6 mph

- Step #8

  52.76   ST

  x   20   Constant

  x   6   % grade

  6,331.2 or 6,331   GR

85

Scraper Production Step #9

- **Return**
  - The return is done by repeating steps 6-9 and **using empty vehicle weight** to get short tons.
- Example:
  - Step #6: **Short tons (ST) with empty vehicle weight.**

    66,590   GW

  - Step #7: *Rolling Resistance (RR)*

    33.30 ST

    x   65 RRF

    2,164.5 or 2,165 RR

  - Step #8: *Grade Resistance/Assistance (GR/GA)*

    33.30 ST x 20 x -2

Scraper Production Step #9

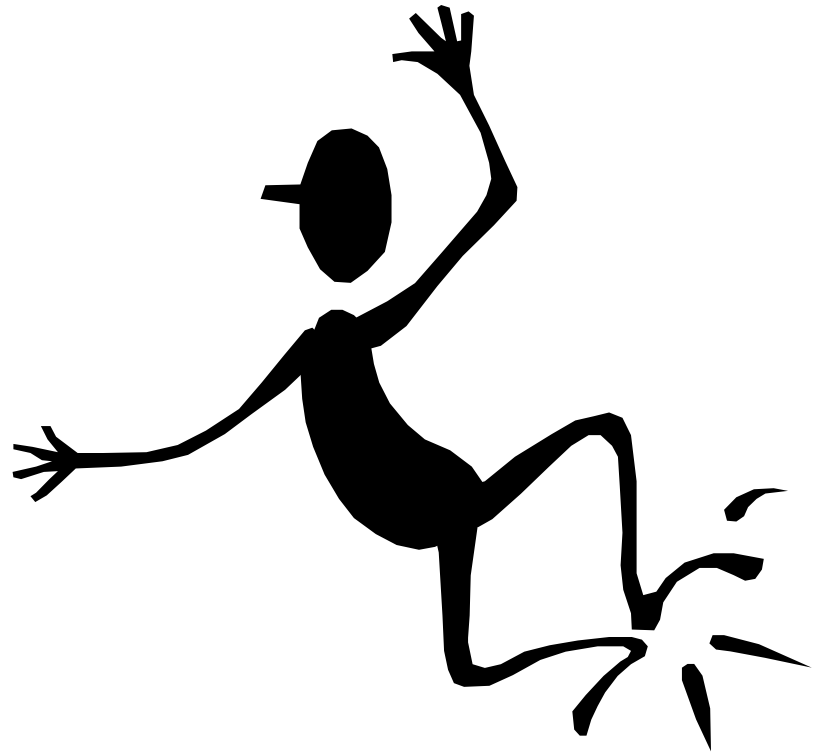- Step #9: *Required Pounds Of Pull (REQPP) & Travel Speed.*

$$2,165 \quad RR$$
$$\underline{-1,332} \quad GA$$
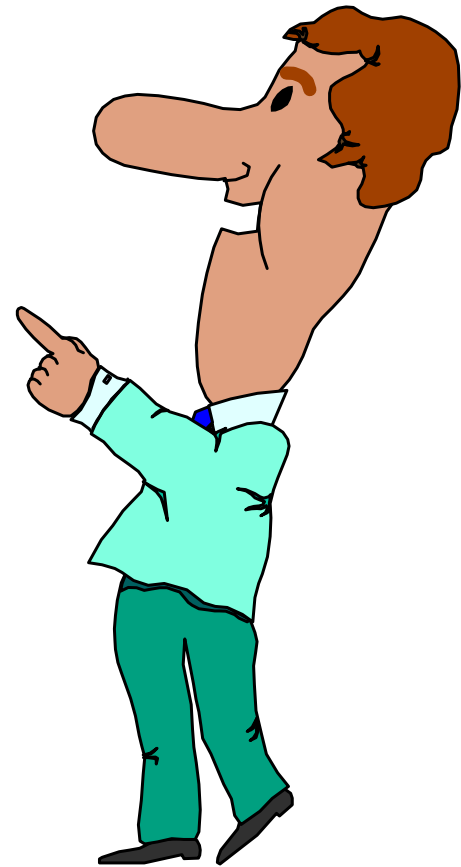$$833 \quad REQPP$$

8th gear / 26 mph

- Now that you have you travel speed for haul **and return**, you can formulate the cycle time (step 10).

Scraper Production Step #10

- ***Cycle Time***
  - The time required to **Load, Haul, Spread**, and **Return**.
  - This is figured by adding **Fixed Time (Fix-T)** and **Travel Time (TT)** to get **Cycle Time (CT)**

Scraper Production Step #10

Fixed Time:
- Is the time spent during an equipment cycle other than hauling and returning.
- This includes positioning , loading, unloading, turning, accelerating and decelerating, all of which are fairly constant or fixed.
- Fixed times are determined from Table #6-2.
- To use Table #6-2, start with what gear you are in.

Scraper Production Step #10

Table #6-2 Fixed Time

Equipment	1st,2nd,3rd 5th,6th,7th,8th		4th			
Loading Haul	Gear Haul		Gear Haul		Gear	
Scraper	Struck	Heap	Struck	Heap	Struck	Heap
Scraper Loading Itself	2.50	N/A	2.80	N/A	3.0	N/A
1155E	7.0	9.0	7.30	9.30	7.50	9.50
TRAM	6.0	7.0	6.30	7.30	6.50	7.50
1085 w/1.5 bucket	12.0	14.0	12.30	14.30	12.50	14.50

Scraper Production Step #10

- Travel Time:
  - The time spent on the haul road transporting material and returning empty.
  - Travel Time depends on: size of hauling unit, rolling resistance, grade resistance, and distance traveled.
  - All of which have already been figured to get your gear selection and speed to put in your cycle time formula.

Scraper Production Step #10

To figure cycle time (CT) you must first figure travel time (TT).

- To get travel time divide the distance in feet of the haul or return road by the sum of the travel speed (TS) in mph multiplied by 88.

- Do this for the haul and return.

- The total time plus fixed time will equal total cycle time.

- Note: 88 is he conversion factor to change the speed in mph to feet

92

Example

A 621B scraper, hauling 17.5 CY of material, travels 7500' to the fill area using 6th gear and returns empty by a different route of 8200' in 8th gear.

■ ___7500'___ haul dist.

14 TS x 88   =   6.09 HT

■ ___8200'___ return dist.
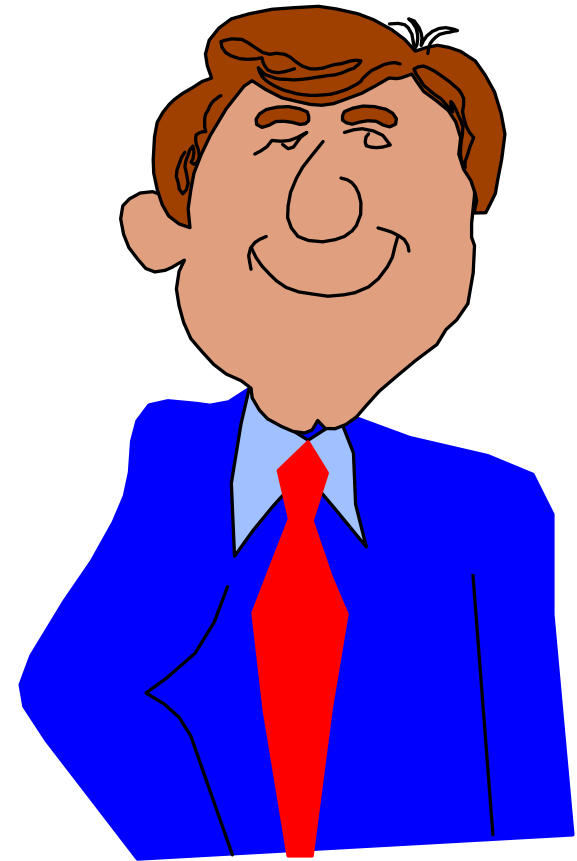
26 TS x 88   =   3.58 RT

What Have You Learned?

- Problem #1
  - Figure total cycle time.
  - 621B, self loaded
  - Haul distance - 8250'
  - Return distance - 7125'
  - Haul gear - 4th
  - Return gear - 8th

Solution

- 8250' HD
  8 TS x 88   = 11.72 HT

- 7125' RD
  26 TS x 88 = 3.11 RT

- 11.72 + 3.11 + 2.80 =

  17.63 CT

What Have You Learned?

Problem #2
- Figure total cycle time.
- 621B, self loaded
- Haul distance - 9000'
- Return distance - 9176'
- Haul gear - 6th
- Return gear - 8th

96

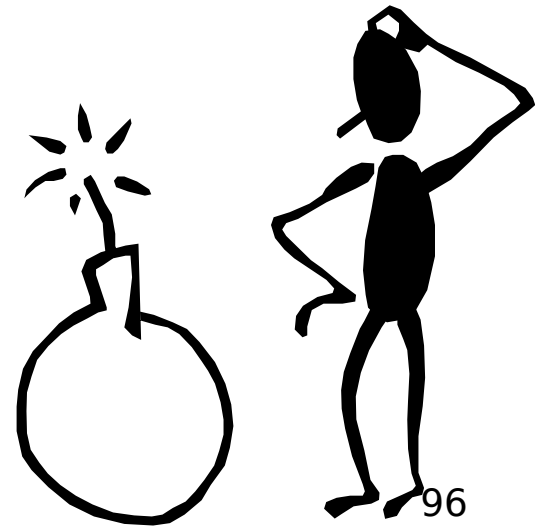# Solution

- 9000' HD

  14 TS x 88 = 7.31 HT

- 9176' RD

  26 TS x 88 = 4.01 RT

- 7.31 + 4.01 + 3.0 =

  14.32 min CT

Scraper Production

- Take A Break!

Scraper Production Step #11

- ***Trips Per Hour*** / ***Example***
  - To determine trips per hour (TPH) divide the work 60 minutes per hour (normally 60 min. cycle time) by the cycle time.
  - However, the scraper can it has a 17.17 min cycle (work hour) by the

  $$\frac{60 \text{ min. worked/hr}}{17.17 \text{ cycle}} =$$

  - Note, never round off TPH.

  3.49 TPH

Scraper Production Step #12

- ***Hourly Production Rate (LCYPH)***
  - To determine the hourly production rate, you must know the actual load size (in LCY), the number of trips per hour,

- TPH

  x ALS

  x Efficiency Factor

  = LCYPH

- Note: always round down LCYPH.

Scraper Production Step #12

Table #7-2 Efficiency Factor

| Type Unit	Operator	Day	Night
Tracked	Excellent Average Poor	1.00 .75 .60	.75 .56 .45
Wheeled	Excellent Average Poor	1.00 .60 .50	.67 .40 .33

- Example:

  – What is the hourly production rate for a 621B with an average operator, working days, making 3.49 TPH, with a load of 17.5 LCY?

  3.49 TPH x 17.5 ALS x .60 = 36.65 or 36 LCYPH

Scraper Production Step #13

- **_Soil Conversion (SC) (if needed)_**
  - in some cases the hourly production rate may be needed in compacted cubic yards (CCY) for a road or runway.
  - Note: round down CYPH.

Loose

Bank

Compacted

102
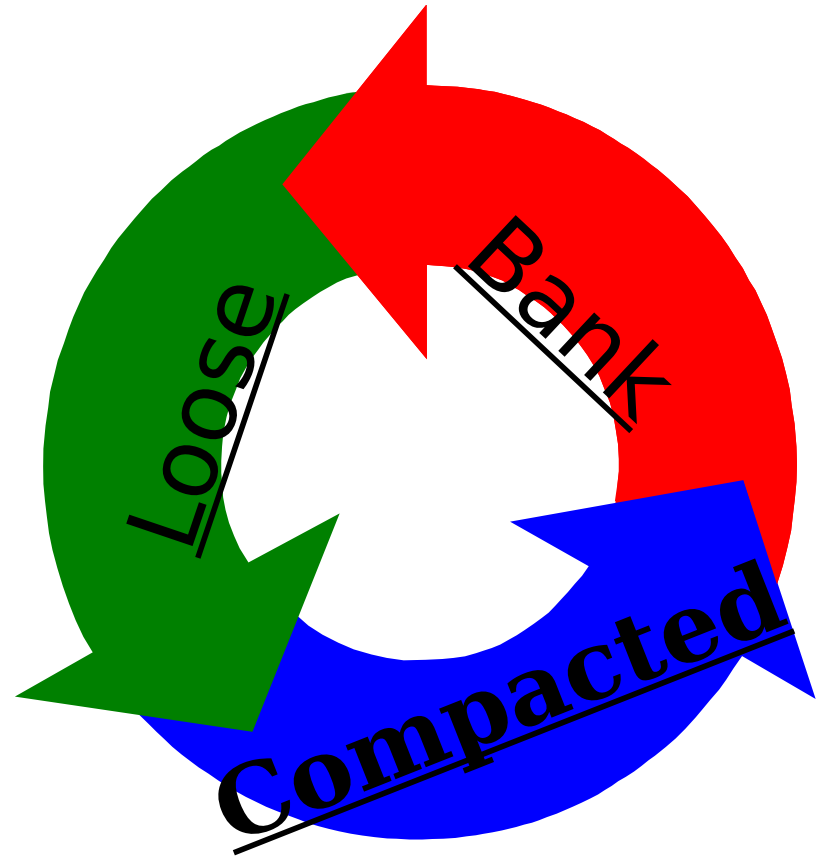
Scraper Production Step #14

Total Hours Required To Complete Mission

– To determine the total time required to complete the mission, you must know the total volume to

- Volume needed (_CY)

  _CYPH x #of scrapers = Total Hours Required

- Note: never round off time.

- Example:

  19,440 CCY

  25 CCYPH x 3 scrapers =

  259.20 hours required

Scraper Production Step #15

- **_Total Production Days_**
  - To get the production days required to complete the mission, divide total hours required by the hours worked

- Example:
  259.20 hours req. ÷ 8 hrs/day

  = 32.40 or 33 days

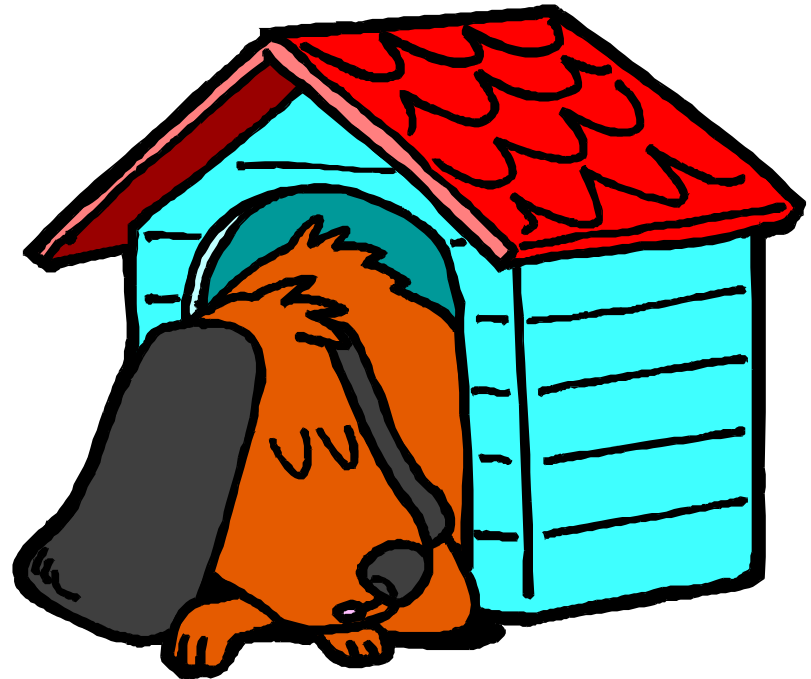- Note: Round days to next full day.

What Have You Learned?

Problem# 1

Figure total number production days with the following factors:

3 621B

– Struck loaded, loam

7 hr. production day

– Excellent operator

13.08 min. cycle time

– Compacted volume required for job 250,000 CY

– Working 60 min/hr

Solution

- Step #11

    $$\begin{array}{r}60 \quad \text{Min/hr} \\ \div 13.08 \ \text{CT} \\ \hline \textcolor{orange}{4.59} \quad \textcolor{orange}{\text{TPH}}\end{array}$$

- Step #12

    $$\begin{array}{l}4.59 \ \text{TPH} \\ \times \ 14 \ \text{ALS} \\ \times 1.0 \ \text{Efficiency factor} \\ \hline 64.26 \ \text{or} \ \textcolor{orange}{64} \\ \textcolor{orange}{\text{LCYPH}}\end{array}$$

- Step #13

    $$\begin{array}{l}64 \ \text{LCYPH} \\ \underline{\times .72} \ \text{Conversion Factor} \\ 46.08 \ \text{or} \ \textcolor{orange}{46} \\ \textcolor{orange}{\text{CCYPH}}\end{array}$$

- Step #14

    $$\begin{array}{l}\underline{250,000} \quad \text{Req vol} \\ 46 \ \text{x} \ 3 = \\ \textcolor{orange}{1,811.59 \ \text{hrs}}\end{array}$$

- Step #15

    1,811.59 hrs req

What Have You Learned?

Problem #2 A project requires you to build a parking lot using gravel. How many work nights, at 8 hours per night, are require to complete the project? You are working only during hours of darkness. The job conditions are as follows.

5 621B, Compacted fill required 150,000 **CY**

– Struck loaded, Gravel, moisture content 14%

– Haul distance 7000 ft, return same route

– Grade of haul road 6% downhill, Average operator

– Rutted, dirt roadway, with no stabilization under 4" to 6" penetration

Solution

- Step #1

  3000

  X 1.14

  3420 ASW

- Step #5

  3420   ASW

  x 14 ALS

  47,880   LW

- Step #6

  47880

  +66590

  114470

  ÷ 2000

  57.24   **ST**

- Step #7

  57.24

  x 150

  8586 **RR (HAUL)**

Solution

- Step #7

  33.30

  X 150

  4995
  RR(RETURN)

- Step #8

  57.24

  x 20

  x -6

  -6868.8 or 6869
  GA (haul)

- Step #8

  33.30

  x 20

  x   6

  3,996 GR
  (RETURN)

- Step #9

  8586 RR

  -6869 GA

  1717 **RPP (HAUL)**

  8TH   26MPH

Solution

- Step #9

  4995 RR

  $\underline{+3996}$ GR

  8991

  RPP(RETURN)

  5ᵀᴴ 11MPH

- Step #10

  $\underline{7000'}$

  26 x 88 = 3.06

  HT

- Step #10

  $\underline{7000'}$

  11 x 88 = 7.23.

  RT

  3.06 + 7.23 + 3.00 = 13.29

- Step #11

  60 **Min/HR**

  $\underline{÷13.29}$ **CT**

  4.51 **TPH**

110

Solution

- Step #12

  4.51   TPH

  x 14 ALS

    x .4   EFF. FAC.
  _____

  25.26 or 25 LCYPH

- Step #13

  25 LCYPH

  x .86   Conv. Fac.
  _____

- Step #14

  150000
  _____

  21 x 5 = 1428.57 **THR**

- Step #15

  1428.57 THR

  ÷   8   **HRS/NIGHT**
  _____

  178.57 or 179 **NIGHTS**

- QUESTIONS??

- Take a break!!

Push Loading

- One of the most effective methods of loading a scraper.
- Decreases time, and distance.
- Usually, a 621B is pushed by a MCT.
- The MCT has a reinforced blade for push loading.
- Load time should be 1 min. or less.
- The optimum loading distance is around 90' - 125'.
- The optimum depth of cut is 4" - 6".
  – Varies according to type of soil,moisture content, loadability, operator, load size,and method of employment.

113

Push Loading

- 2 mph for the MCT and first gear for the 621B.

- The Mph listed In table #5-2 for the scraper and table #8-2 for the MCT reflect maximum and/or average speed in mph.

- When push loading is employed, the maximum mph will not be the loaded mph reflected in the tables, therefore, **for classroom purposes, use 2 mph when push loading.**

Push Tractor Step #1

Figuring the number of push tractors (PT) needed.

- *Load Time (LT)*
- The time required to load the haul unit during which the dozer is in contact with the

- Length of cut

  mph x 88 = LT in min.

- Example:

  150' length of cut

  2 mph x 88 = .85 LT

Push Tractor Step #2

- **Boost Time (BT)**
  - The time expended after the scraper is loaded during which the push tractor assists the scraper in attaining momentum. (for boost time use a constant of .25)

116

Push Tractor Step #3

- ***Return Time (RT)***
  - the time required for the push tractor to return to the starting point.
  - This portion of the cycle time will be greatly reduced by chain

- LT x 1.4 = RT
- Example:

$$
\begin{array}{ll}
.85 & \text{LT} \\
\underline{\text{x 1.4}} & \text{Constant} \\
1.19 \text{ min.} & \text{RT}
\end{array}
$$

Push Tractor Step #4

Formulate Cycle Time
 (Load Time x 1.4) + Boost Time = PT Cycle
  Time (CT)

Example:

(.85 x 1.4) + .25   =   1.44 min PT CT

NOTE: NEVER ROUND OFF TIME
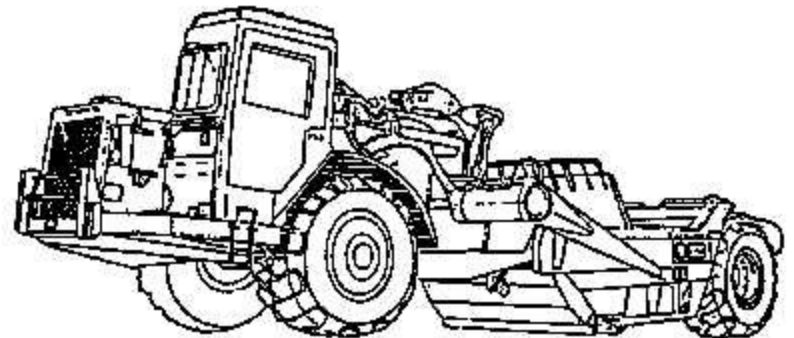
Push Tractor Step #5

- ***Number Of Scrapers A Push-Tractor Can Support***
  - This is found by dividing scraper cycle time by the push-tractor time.
  - **Example:**
  - How many scrapers can a single push-tractor support if the scraper cycle time is 4 min. and the push-tractor cycle time is 1.3 min.?

- 4 min Scraper CT

  ÷1.3 min   PT CT

  3.08 Round down to 3

Push Tractor Step #6

■ **Number of Push-Tractors Required**

– This is found by dividing the number of scrapers on the job, by the number of scrapers a push-tractor can support.

■ Example:

– How many push-tractors are required on a job that has 9 621B's, if a single push-tractor can support 3 scrapers?

9 Scrapers

What Have You Learned?
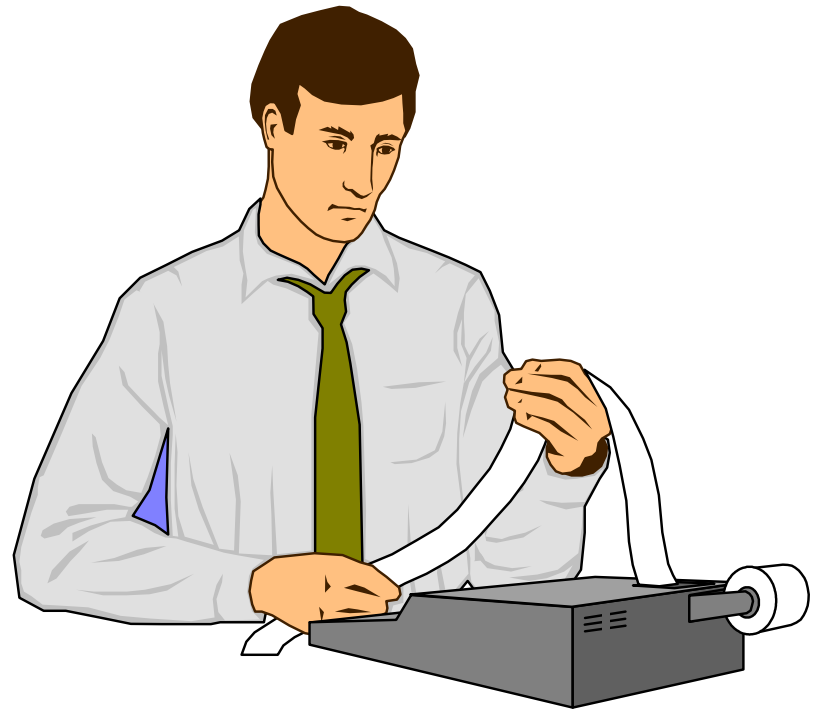
- **Problem #1**
  - Figure the number of push-tractors required for :

  4 621B

  12.58 min cycle time

  150' cut

Solution

- **Step #1** / **Step #4**

  1.15 R / 150 Length of cut

  4.25 BT

  ÷(2×88) / 1.44 min PT CT

  mph × conv.factor

- Step #5

  .85 LT

  12.58 CT

  ÷1.44 PT CT

  .25 BT

  8.74 or 8 Scrapers/PT

- Step #2

- Step #3

  .85 LT

Solution

- Step #6

$$\begin{array}{rl} 4 & \text{Scrapers} \\ \div\ 8 & \text{Scrapers/PT} \\ \hline .50 \text{ or } & \text{1 PT} \\ & \text{required} \end{array}$$
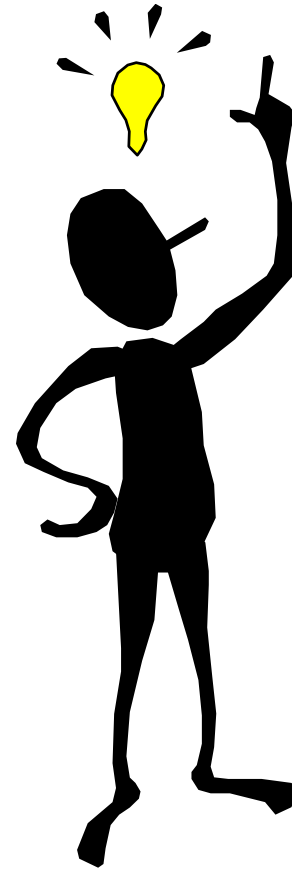
What Have You Learned?

■ ***Problem #2***

– Figure the number of push-tractors required for:

7 621B's

8.92 CT

125' Cut
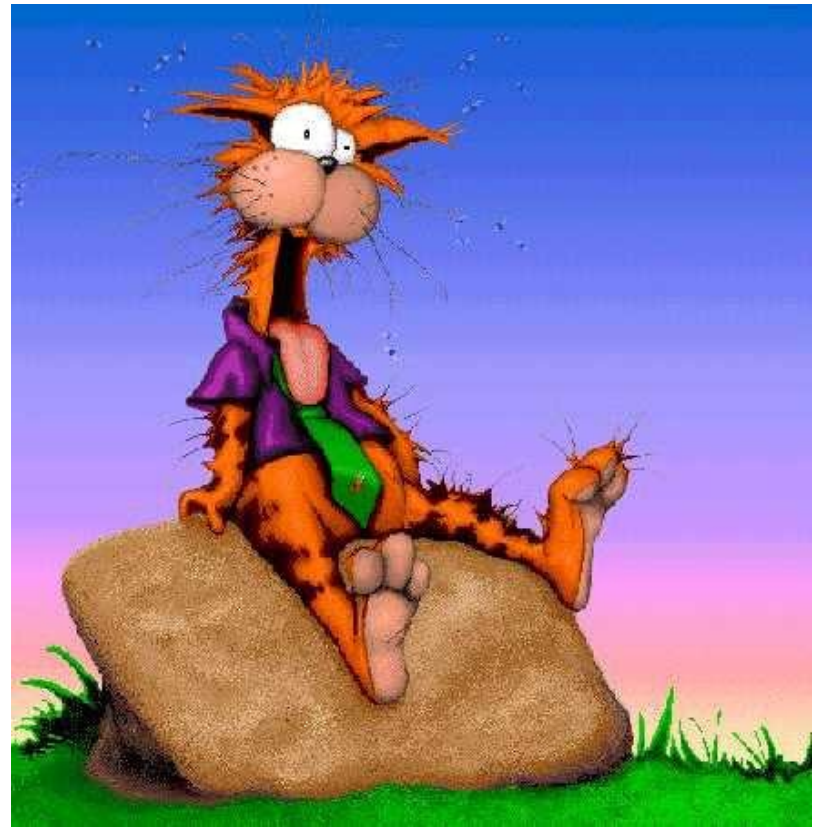
Solution

Step #1

125   Length of cut

$\div(2\times88)$ mph & conv. Factor

.71   LT

Step #2

.25   BT

Step #3

.71   LT

× 1.4 Conv. Factor

Step #4

.99   RT

+.25   BT

1.24 min PT CT

Step #5

8.92   CT

÷1.24   PT CT

7.19 or 7 Scrapers/PT

Solution

- Step #6

$$\begin{array}{r} 7 \\ \div\ 7 \\ \hline \end{array} \quad \begin{array}{l} \text{Scrapers} \\ \text{Scrapers/PT} \end{array}$$
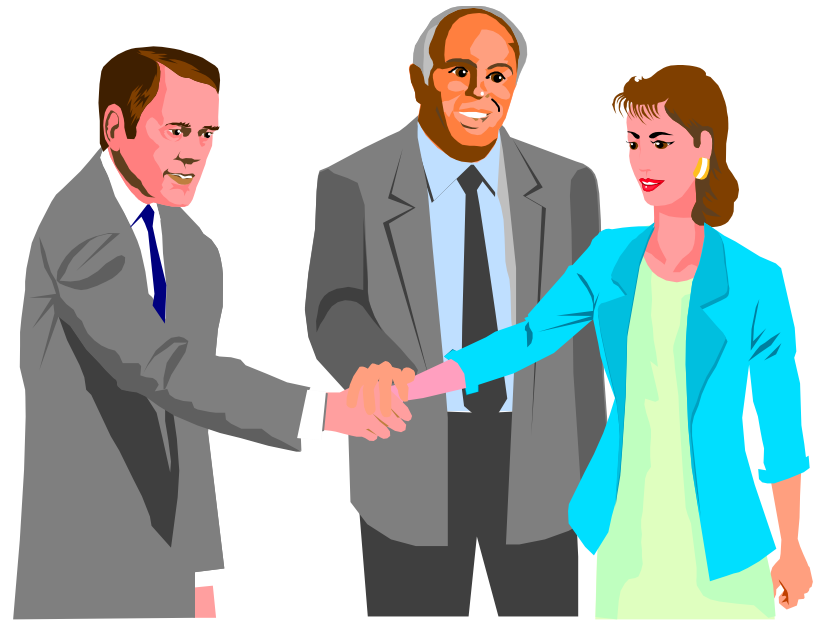
1 PT required

What Have You Learned?

Problem #3

– A project requires you build a road using clay and gravel with an 8% moisture content.

– The borrow pit area allows you to push load the 621Bs with MCTs.

– How many days are required?

– Show and label all figures and formulas.

127

Solution

- Days
- Step #1
  2,916ASW
- Step #2
  14   CY/load
- Step #3
  N/A
- Step #4
  N/A
- Step #5
  40,824   LW
- Step #6
  – Haul

107,414 GW
53.71ST
– Return
33.30ST
- Step #7
  – Haul
  5,371RR
  – Return
  3,330RR
- Step #8
  – Haul
  7,519GR
  – Return
  4,662GA

Solution

- Step #9
  - Haul
    12,890   REQPP
    4th gear 8 mph
  - Return
    -1,332   REQPP
    8th gear 26 mph
- Step #10
    9.38 HT
    2.88 RT
    13.99CT

- Step #11
    4.29 TPH
- Step #12
    36   LCYPH
- Step #13
    22   CCYPH
- Step #14
    1,325.76   Hrs Req
- Step #15
    133   Days

Solution

- **# of RT Required** Step #5

  15 #scrapers/dozer

- Step #6 Step #1

  .145 PT required

- Step #2

  .25 BT

- Step #3

  .63RT

- Step #4

Push Tractor Production

- Questions?

- Take A Break!
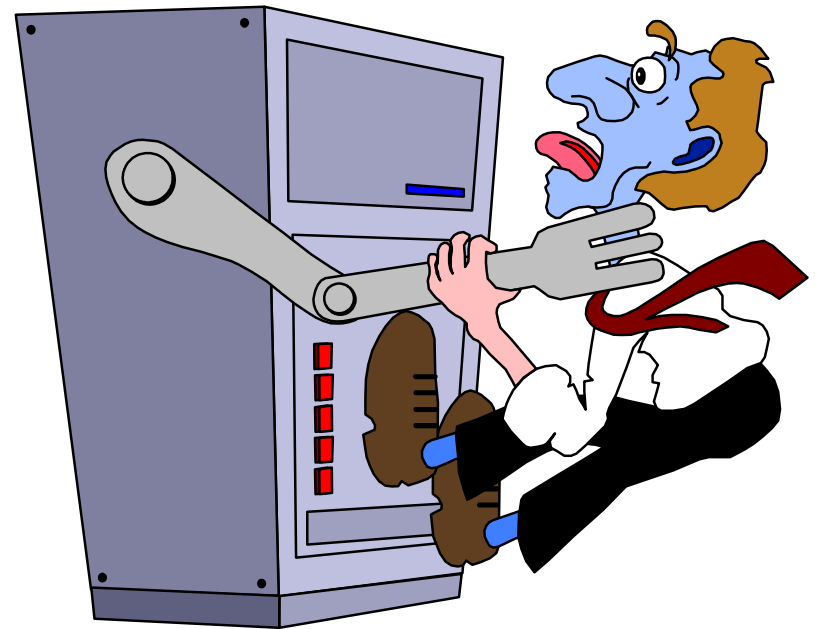
Dozer Production

- Introduction
  - Dozers and scrapers are the most common pieces of equipment on a project.
  - It is important to be able to properly use these earthmovers to, get maximum production, to establish production estimation rates, and to insure the prompt completion of an earth moving task.

Dozer Uses

- Used as prime movers for pushing or pulling loads.
- Used for power units for winches and hoists.
- As moving mounts for dozer blades.
- Used primarily where it is advantageous to obtain high drawbar pull and traction.
- Most suitable equipment for pushing or pulling loads through marshy areas.

Dozer Classification

- Crawler tractors are classified according to weight.
  - Light (1150 & 1155)
  - Medium (MCT)
  - Heavy (D8)
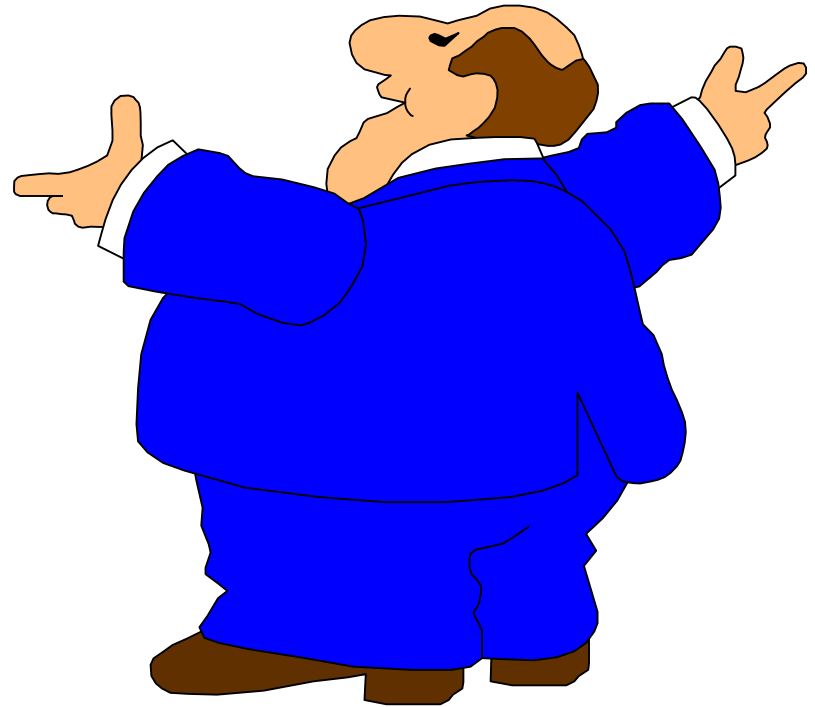
Dozer Characteristics

- Supported on the ground by track assemblies.

- Commonly called bulldozers, they are the work horses of construction.

- Usually the first piece of equipment on job site, last to leave.

- Used to cut haul roads, move dirt, trees, rocks, and many other.

- Simply a tractor with a blade mounted on the front which is used for pushing objects or materials.

135

Dozer Characteristics

- Once the blade is removed, it's used as a towing unit.
- Since the weight of the machine is supported by the track sections, the crawler tractor has great traction pull.
- The ability to "lock" one side section of track while pulling with the other one enables the crawler tractor to pull itself out of material that would easily cause a wheeled machine to become stuck.

Dozer Operation

- Equipped with a diesel engine rated from 85 to 202 horsepower, and either 4 or 6 cylinders, depending on make and model.

- Low ground bearing pressure, varying form 6 - 9 lbs./Sq. in., which gives it distinct "floatation" advantage.

- Capable of operating in muck or water as deep as the height of the track.

- Can move to jobsite on own power, but transporting is preferred.

Dozer Production

- Estimated using the production from Table #9-3, and then adjusting the table with six correction factors.

Dozer Production

Formula

Factor 1 x Factor 2 x Factor 3 x Factor 4 x Factor 5 x Factor 6 = LCYPH

Note: Round down LCYPH

For classroom purposes, if you are not given the information for any step, that step will be N/A.

Dozer Production Factor #1

- **Maximum Basic Production**
  - Find the average dozing distance line on the bottom of the scale.
  - Read up until you intercept the production curve for the dozer you are using.
  - Then read to the left to get the production rate in LCYPH.

- Note:
  - On the charts the **4S** is the **1150E** and the **7S** is the MCT.

- Example
  - Determine the maximum basic production for a MCT with an

Dozer Production Factor #1 (1150)

LCY per hour vs Average dozing distance (feet). Curves labeled 6S, 5S, 4S, 3S.

Dozer Production Factor #1 (MCT)

LCY per hour vs. Average dozing distance (feet), with curves labeled 8S and 7S.
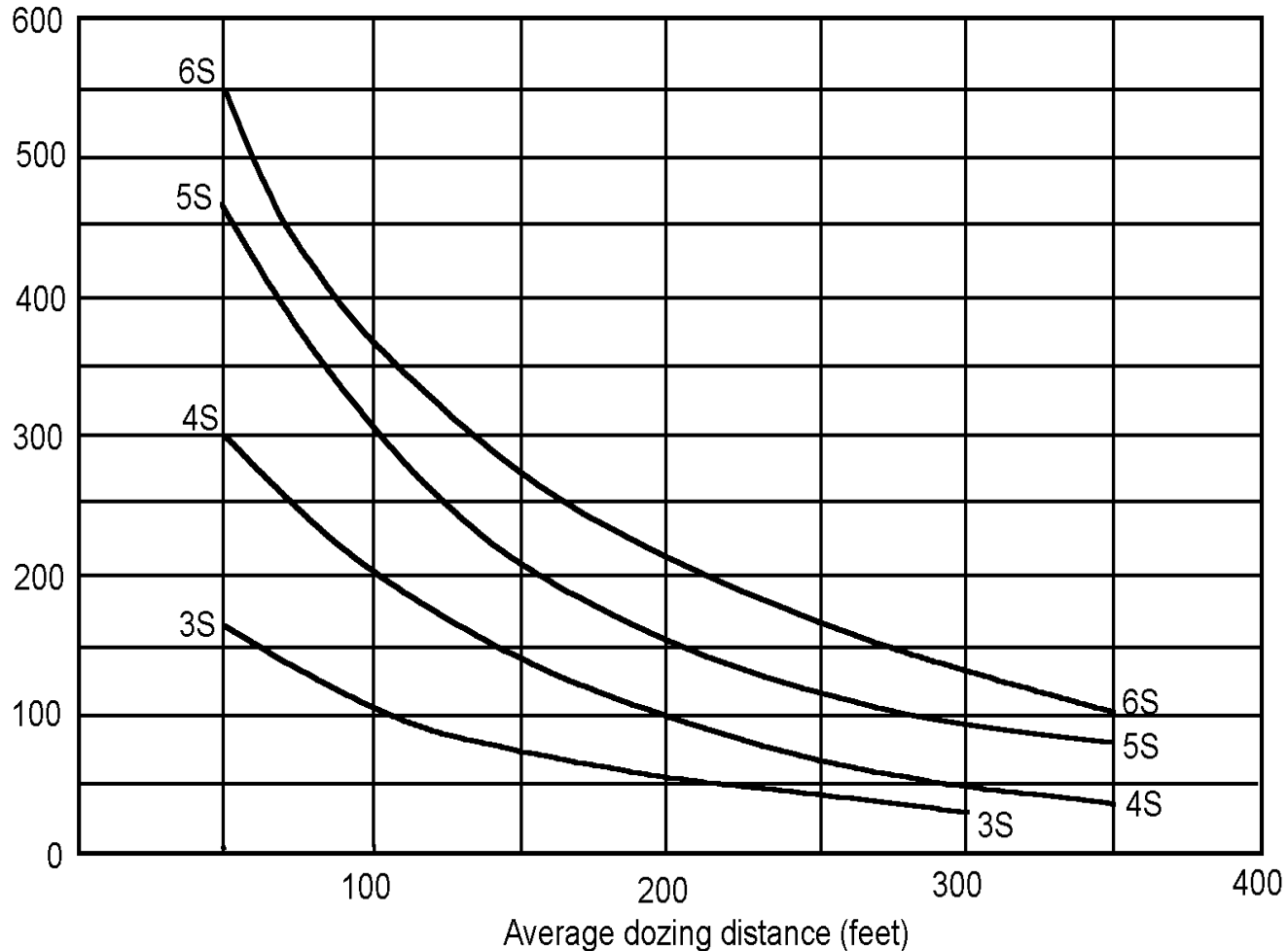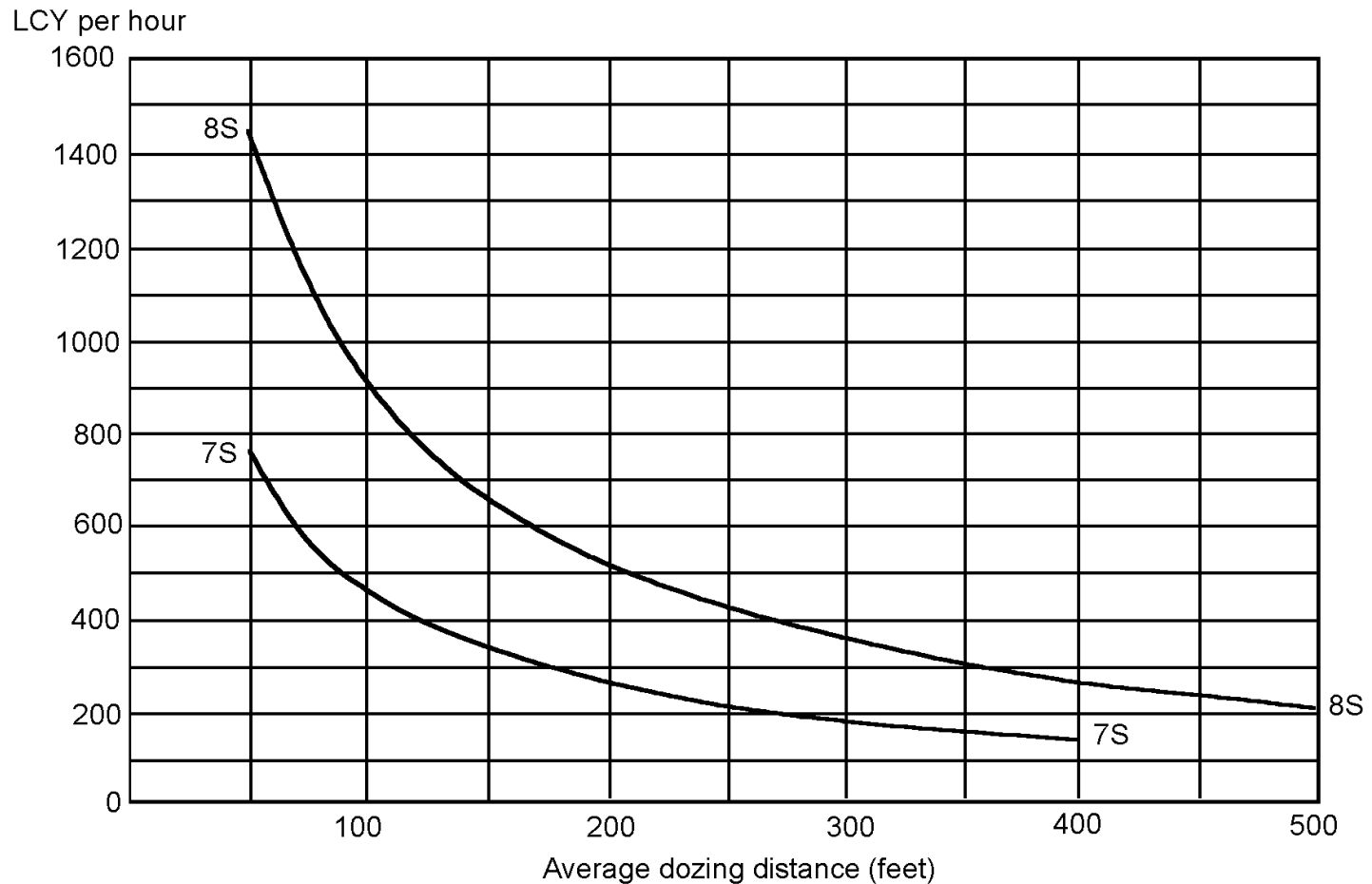
Dozer Production Factor #2

Grade Correction Factor

- Using table #10-3 find the % of grade (-) favorable, (+) unfavorable, on the top of the scale, read down until you intercept the grade correction curve.
- Read to the right to determine the grade correction factor.
- Each vertical line on this scale represents multiples of two.
- Each horizontal line represents 0.04.
- Note: For classroom purposes round off, up or down to the closest factor.

143

144
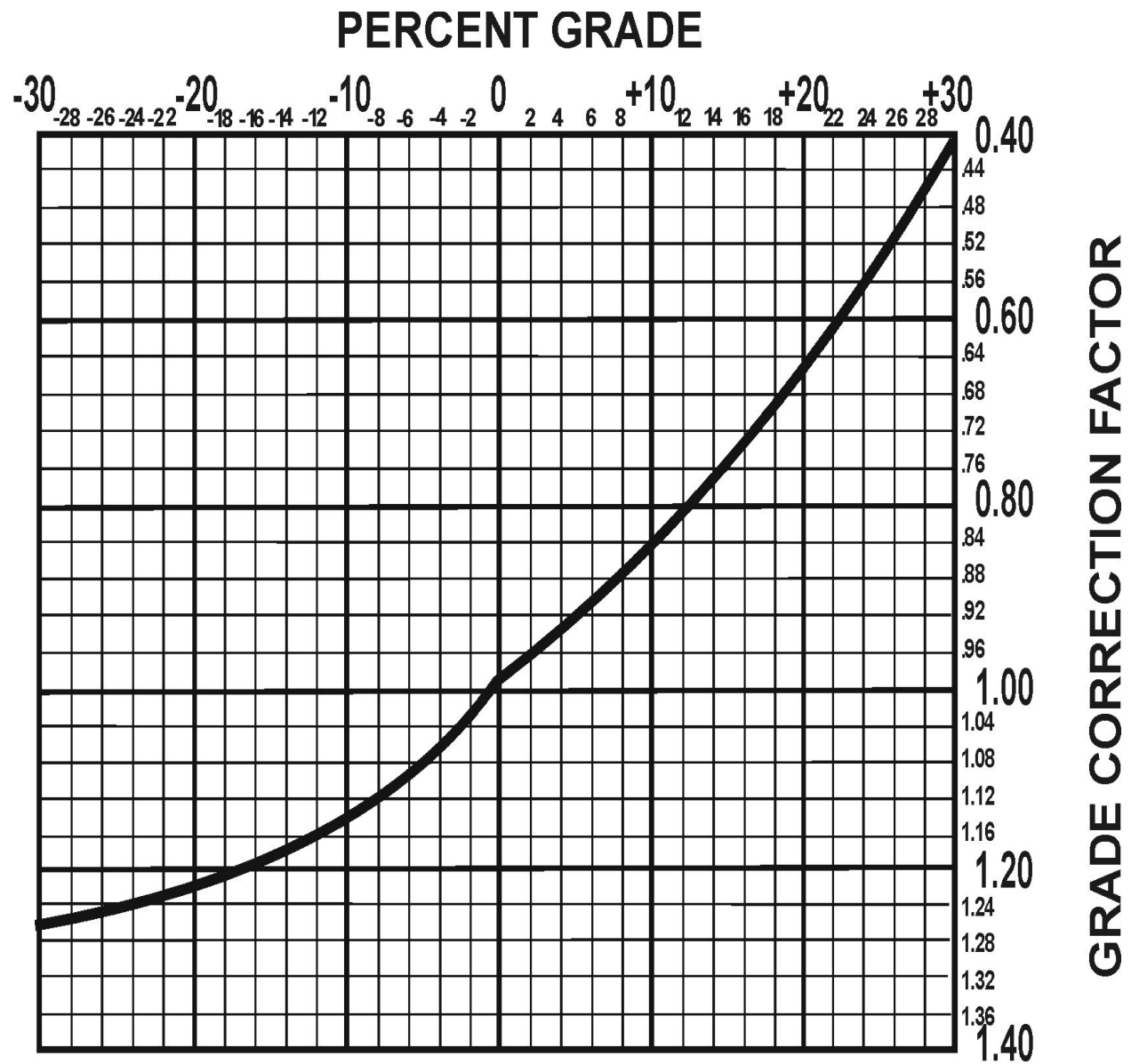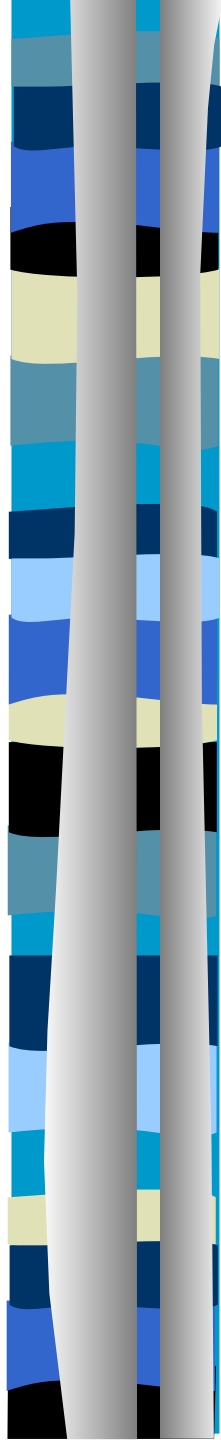
Example

- If you had to move the material up a 2% grade (+), what would be your grade correction factor?

  .96

Dozer Production Factor #3

- ***Soil Weight Correction Factor***
  - Using table #2-2 as before, get your ASW.
  - Divide 2,300 lbs./CY by you ASW to find the correction factor.

    2,300 lbs. is a constant which is the weight of soil used to determine table #9-3.

- Example:
  - You are working in clay with a 5% moisture content.

2,300	Constant
÷2,100	ASW
1.10	Soil weight correction factor

Dozer Production Factor #4

■ Soil Type Correction Factor

– The dozer blade is designed to cut the material and give is a rolling effect for a production factor of 1.00.

– Material found in different states will effect dozer production as in the following table.

Table # 15-3 Soil Type	Soil Correction Factor
Loose, Stockpile	1.20
Hard to cut (with tilt cylinder)	0.80
Hard to cut (without tilt cylinder)	0.70
Hard to Drift (sticks to blade)	0.80
Rock, Ripped or Blasted	0.60

147

Dozer Production Factor #5

Equipment/Operator Efficiency Correction Factor

– These factors include operator efficiency and visibility (dust, rain, snow, fog, and darkness) with a job efficiency of a 60 min. hour.

Table #7-2 Equipment/Operator Efficiency Factor

Type Unit	Operator	Day	Night
Tracked	**Excellent**	1.00	0.75
	Average	0.75	0.56
	Poor	0.60	0.45

148

Dozer Production Factor #6

- **Management Technique Correction Factor**

Table #12-3

Management Technique	Factor
Slot Dozing	1.20
Side By Side Dozing	1.15

149

Dozer Production Step #1

Production Calculation

Factor #1

x Factor #2

x Factor #3

x Factor #4

x Factor #5

x Factor #6
_____

LCYPH/dozer

Note: Round down LCYPH
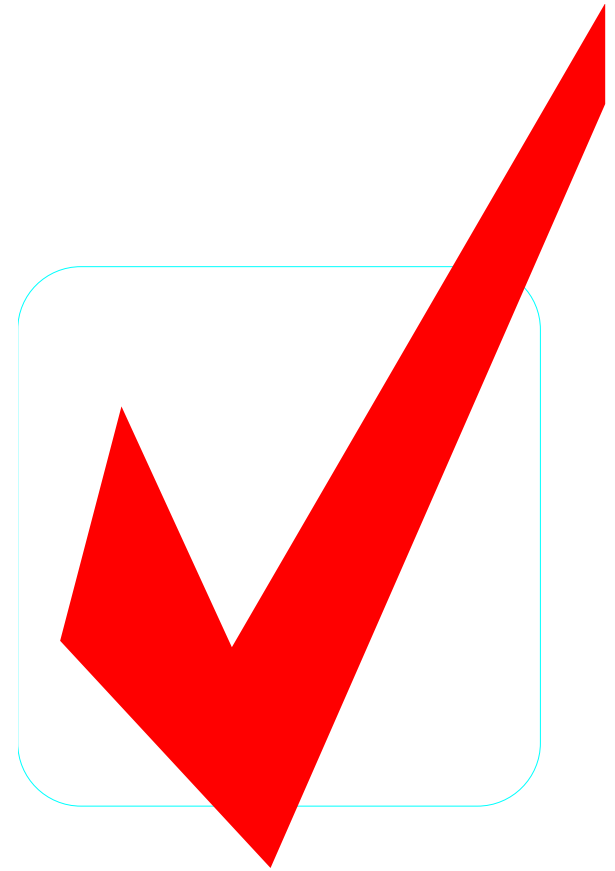
Dozer Production Step #2

- **Soil Conversion Factor (if required)**
  - Convert soil by using table #1-1 as before.

Bank

Loose

Compacted
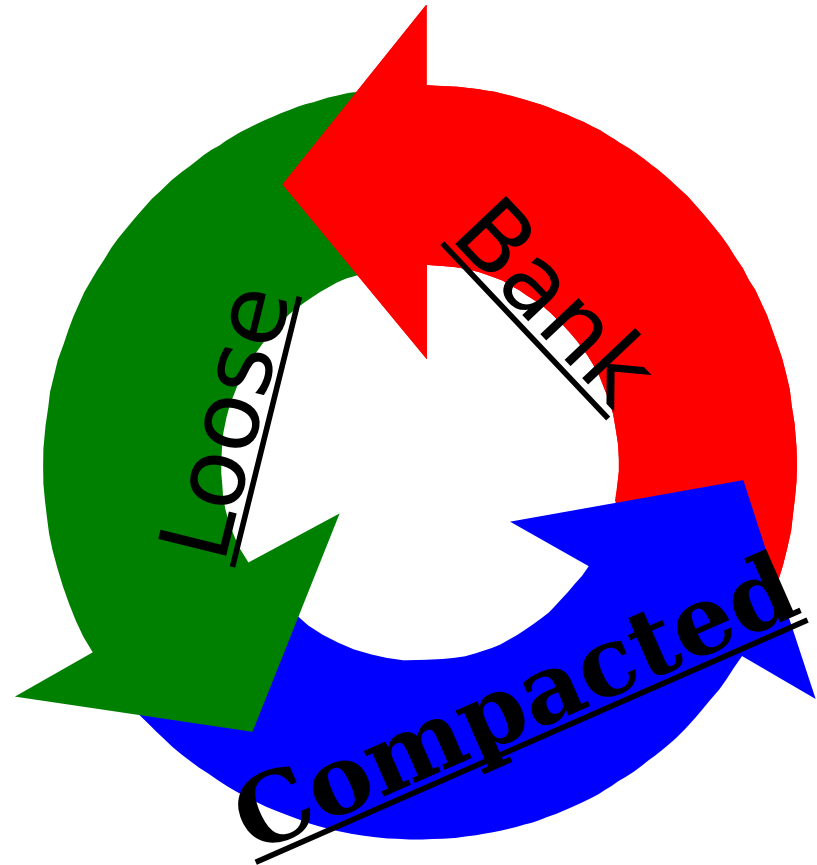
Dozer Production Step #3

Total Hours Required

– Quantity to be moved, divided by the hourly production rate, multiplied by the number of dozers you have employed, equals the total

■ Example:

– How long would it take to move 4,500 CCY of clay, using 3 MCTs with a production rate of 143 CCYPH?

4,500 CCY

÷(143x3) Basic prod. Rate x

dozers

10.49 hrs.

Dozer Production Step #4

- Total Production (Days)

- Example:

  10.49   Hrs required

  ÷ 8   Hrs/day

  1.31 or 2 Days

- Note: round days to next full day.
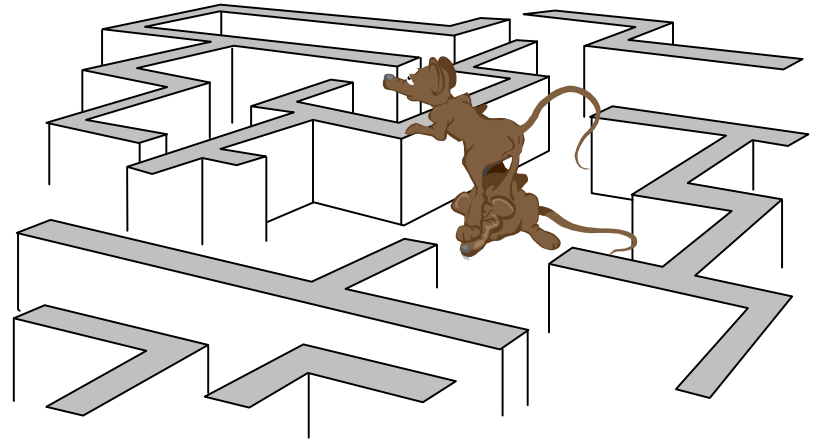
Dozer Production Step #5

- Total Number of Dozers Required
  - Quantity of material to be moved
  - Divided by the hourly production rate.
  - Multiplied by the number of hours you have to complete the job.

Example

- How many MCTs would be needed to move 4,500 CCY of loam in 5 hrs. if the dozers have a hourly production rate of 143 CCYPH?

4,500 CCY required

What Have You Learned?

- **_Problem #1_**
  - Using the information in your handout, determine how long it will take 2 MCTs to complete the job:
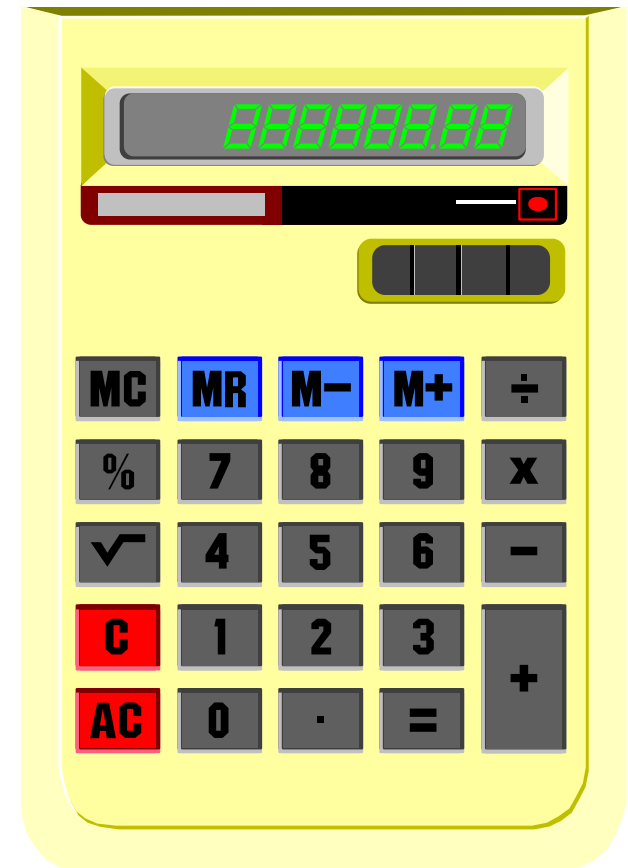
Solution

Factor #1
  300 LCYPH Max. basic prod.
Factor #2
  .96 Grade correction factor
Factor #3
  2,040 ASW
  1.13 Soil wt correction factor
Factor #4
  .80 Soil correction factor
Factor #5
  .45 Equip/Op correct. factor

■ Factor #6
  1.15 Mngt. correct. Factor
■ Step #1
  134.73 or 134 LCYPH
■ Step #2
  84.42 or 84 CCYPH
■ Step #3

156

What Have You Learned?

- **Problem #2**
  - Using the information in your student handout, determine how many MC1150Es are required to complete the job in 5 hours.

Solution

Factor #1
 200 LCYPH Max. basic prod.

Factor #2
 .92 Grade correction factor

Factor #3
 2200 ASW
 1.05 Soil wt correction factor

Factor #4
 .80 Soil correction factor

Factor #5
 1.00 Equip/op correct. factor

- Factor #6
 1.20 Mngt. Correct. factor

- Step #1
 185.47 or 185 LCYPH

- Step #2, 3, 4
 N/A

- Step #5
 3.22 or (4)

Dozer Production Estimation

- Are there any questions?
- Take a break!

Clearing, Grubbing, and Stripping

- ■ *Clearing and Grubbing*
  - • Consists of removing all trees, fallen timber, brush, and other vegetation from a designated area.
  - • Clearing techniques vary with the type of vegetation, soil,and moisture conditions.
  - • Table #14-3 shows average clearing rates for normal conditions.

Stripping

- Consists of removing and disposing of the top soil and vegetation which would be objectionable as a sub-grade for a road or runway.
  - *Brush and small trees:* Dozers operating in 1st or 2nd gear can clear brush and small trees (6" or less in diameter) at the rate of 900 - 1000 sq.yd./hr.
  - *Medium trees:* 7" - 12" trees an average of 2 - 9 min./tree.
  - *Large trees: M*ore than 12" an average of 5 - 20 min./tree.

Production Estimation

Production Estimates

- There are two methods for estimating clearing, grubbing and stripping.
- ***The Quick Method:*** Table #13-3 gives quick estimates for clearing, grubbing and stripping trees. (Avg. 50 trees/acre)
- Use these estimates only when a detailed reconnaissance and tree count are not possible.

Equipment	*Man (Hours*	*Or Per*	*Equipment Acre)*
	Small Trees (6" or less)	Med. Trees (7" – 12")	Large Trees (12" – 30")
Medium Tractor (MCT)	2.50	5.00	10.00
Spade Plow (MCT)	1.33	2.20	3.90
Shear Blade (MCT)	0.40	0.80	1.30

Production Estimation

- Quick method
  - Use this method when a detailed reconnaissance and tree count are not possible.
  - Example: Look at the example in your handout.

- Step #1: Determine the area to be cleared in acres.
  - Change miles to feet.

  2 mi. x 5,280' = 10,560'

  <u>60' W x 10,560' L</u>

  43,560sq ft/acre=14.55 acres

- Step #2: Determine size and # of dozers available.
  - Size MCT # of MCT 2

- Step #3: Determine the size of trees to be

Production Estimation

- Step #4: **Determine Production Rates (hrs/acre) for clearing**.
  - Use table #13-3.
    - Small trees 2.5.hr/acre
- Step #5: **Determine Basic Production Rate (avg hrs/acre)**
  - Average individual production rates **if needed**

- Hr/acre(sm)
+ Hr/acre(med)
+ Hr/acre(lg)
÷ # of different trees
=

Basic Production Rate (hrs/acre)

- Step #6: **Determine Equipment and Operator Efficiency Factor, using Table #7-2.**

164

Production Estimation

Step #7: **Total Hours Required to Complete Mission**

14.55 acres x 2.50 prod. (hr/acre) x 1.6 disp. & strip.

0.75 efficiency x 2 #of dozers

=

38.80 total hours

– Note:

– If estimating clearing and grubbing only, omit 1.6 from numerator in equation.

– The 1.6 hrs. is there for disposal and stripping vegetation.

Production Estimation

- Step #8: **Total Production (Days)**

  38.80 Hrs req ÷ 8 hrs/day = 4.85 or 5 Days

  – Note:
    - Round days to next full day.

What Have You Learned?

- Figure out the problem in your student handout using the Quick Method.

Solution

- 5280'   Feet/Mile   387.84
  x   5   Miles   ÷(.75 x 3)
  26,400' Length   172.37
  THR

  x   80

  2,112,000 SQFT

  ÷   43,560' SQFT Acre

      48.48 Acres

          5 Production

  x   1.6 Stripping

      387.84

Production Estimation

- Step #1: **Tree Count Method**

- Step #2: *Determine area to be cleared in Acres*

- *Example: Determine the avg. # of each size trees and brush/acre.*

- *Step #4: Determine Basic Production Rate (hrs/acre) per tree size using table #14-3.*

$$\frac{L' \times W'}{43{,}560 \text{ sq}}$$

Production Estimation

Step #4 cont.

_ small trees x .50 min/tree = min/acre

_ med. trees x 9 min/tree = min/acre

_ large trees x 20 min/tree = min/acre

min/acre(small) + min/acre(med) + min/acre(lg) = hrs/acre
60 min/hour

Step #5: ***Determine Equipment & Operator Efficiency Factor***

Production Estimation

- Step #6: **Total Hours Required To complete Mission**
  - (Acres) x (hrs/acre) x 1.6

    (Efficiency) x (# Dozers)   = total hours

- Step #7: **Total Production Days**
  - Hrs req ÷ Hrs/work day = days

Clearing, Grubbing, and Stripping

- Are there any questions?
- Take a break!

Grader Production

- **Introduction**
  - Graders a multipurpose machines used primarily for general construction and maintenance of roads and runways.
  - When properly used, the grader can be employed for crowning and leveling, mixing and spreading materials, ditching and bank sloping, and side-casting material.

Grader Uses

- Serve as finishers.
  - Capable of finishing slopes and grades, blending and mixing materials, snow removal, and scarifying.
  - Used in conjunction with other earth movers when leveling, maintaining and spreading.
  - Additional safety precautions should be used when equipment is performing different tasks in the same area.

Grader Classification

- Classified as multipurpose machines.
  - Can be used in a wide variety of operations from the beginning to the end of construction.

Grader Characteristics

- Wheeled vehicles characterized by a moldboard or blade and scarifier.
  - Graders bring elevations to a final grade.
  - The blade is used to side cast material it encounters.
  - Blade ends can be raised or lowered together or separately.
  - Blade can be pitched.
  - The scarifier is used to break up material too hard for the blade to cut.
  - It is composed of 11 removable teeth capable of cutting to a depth of 12".

Grader Operation

- Hydraulically operated and powered by a diesel engine.
  - Effective during leveling, ditching, and snow removal.
  - During ditching operations, the grader can make progressive cuts to a depth of 3'.
  - The grader has a high center of gravity.
  - Used to create bank slopes.
  - Maintains haul roads. This is done by working material from one side of the road to the other.
  - Corrugated material should be scarified prior to leveling and compacted after the grader has made the final leveling passes.
  - During snow removal, the blade should be inspected hourly for excessive wear.

Grader Production

The time required to complete a grader operation depends on the number of passes necessary and the speed maintained on each pass.

- A work time formula may be used to prepare preliminary estimates of the total time in hours required to complete a grader operation.
- Total Time = $\underline{P \times D}$
-             $S \times E$
  - P = # of passes required
  - D = Distance in miles/ pass

Grader Factors

Number of Passes (P): The number of passes depends on the operation.

- Careful consideration must be made when determining the "# of passes" required.
- These passes must be based upon the effective grading width of the moldboard in the material worked, and/or the # of passes required for cut or fill a given lane which will bring the surface to the desired grade.
- Note: When a grader makes a number of passes covering a distance of less than 1000', it is normally more efficient to back the grader the entire distance to the start point. This is

179

Grader Factors

Distance (D): Distance traveled in each pass is expressed in miles and is determined before construction begins.

Note: If the distance has

Efficiency Factor (E): The grader efficiency factor takes into account the fact that a 60 min. work hour is attained.

Efficiency varies depending on supervision, operator skill, maintenance requirements and the site conditions.

This formula is based on a 60% efficiency

Grader Factors

Speed (S): Speed is expressed in mph.

It is the most difficult factor in the formula to estimate correctly.

As work progresses, conditions may require that speed estimates be increased or decreased.

The work output is computed for each operation which is performed at a different rate of speed.

The sum of all the values obtained in each part is the total time required for the operation.

Care must be taken to use the correct number of passes for each speed used.

181

Grader Production

Table #15-4 130G Grader Speed Per Gear

Speed both forward and reverse in MPH						
GEAR	**1ST**	**2ND**	**3RD**	**4TH**	**5TH**	**6TH**
MPH	2.3	3.7	5.8	9.6	15.5	24.5

Production Estimation

Example:
- (Passes 1 & 2 in 2nd gear)

$$\frac{2 \text{ (passes) x 5 (distance)}}{3.7 \text{ (speed) x .60 (efficiency factor)}} = \frac{10}{2.22} = 4.5 \text{ hrs.}$$

- (Passes 3 & 4 in 3rd gear)

$$\frac{2 \text{ (passes) x 5 (distance)}}{5.8 \text{ (speed) x .60 (efficiency factor)}} = \frac{10}{3.48} = 2.87 \text{ hrs.}$$

- (Passes 5 & 6 in 5th gear)

$$\frac{2 \text{ (passes) x 5 (distance)}}{15.5 \text{ (speed) x .60 (efficiency factor)}} = \frac{10}{9.3} = 1.08 \text{ hrs.}$$

$$4.5 + 2.87 + 1.08 = 8.45 \text{ total hrs.}$$

Production Estimation

Example:

$$\frac{1500 \text{ ft}}{5280} = .28 \text{ miles}$$

(Passes 1 & 2 in 2nd gear)

$$\frac{2 \text{ (passes) x .28 (distance)}}{3.7 \text{ (speed) x .60 (efficiency factor)}} = \frac{.56}{2.22} = .25 \text{ hrs.}$$

– (Passes 3, 4 & 5 in 3rd gear)

$$\frac{3 \text{ (passes) x .28 (distance)}}{5.8 \text{ (speed) x .60 (efficiency factor)}} = \frac{.84}{3.48} = .24 \text{ hrs.}$$

.25 + .24 = .49 total hrs.
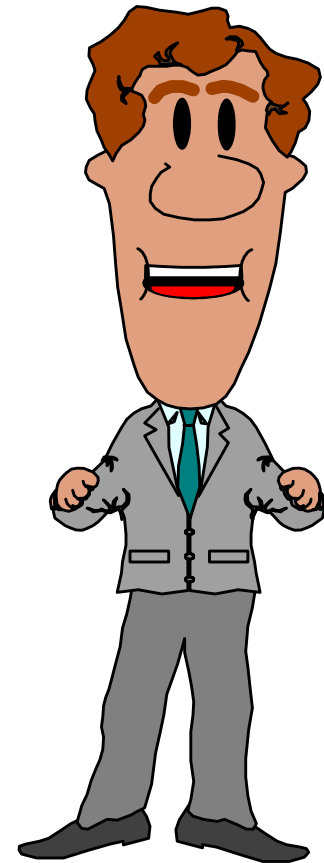
– **Total Production Days**

.49 hrs. ÷ 8 hrs/day = 0.06 or 1 day

184

Production Estimation

- What Have You Learned?
- Problem #1

- Problem #2

Solution Problem #1

- Passes 1 & 2

$$\frac{2 \times 6}{2.3 x.60} = \quad 8.70 hrs$$

Passes 3 & 4

$$\frac{2 \times 6}{3.7 x.60} = \quad 5.41 hrs$$

Passes 5 & 6

$$\frac{2 \times 6}{9.6 x.60} = \quad \underline{2.08}$$

16.19 THR

Solution #2

- 2,640 ÷ 5,280 = .5 Miles

Passes 1 & 2   .72

  2 x .5 = .72 hrs   + .29

2.3 x .60   .11

Passes 3 & 4   1.12 THR

  2 x .5

5.8 x .60 = .29 hrs

Passes 5 & 6

  2 x .5

15.5 x .60 = .11 hrs

Questions?

- Break!

Scoop Loader Production

■ Introduction

- Loaders are available in varied sizes and bucket capacities.

- Loaders have a hinged frame which provides the steering, this steering method is referred to as articulated, and provides greater maneuverability.

- Articulated steering provides zero clearance for personnel at the point of articulation.

- Most loaders have a towing pintle for towing small trailers.

- Special caution should be exercised when the bucket is fully raised, because the chances of rollover or tipping are greatly increased
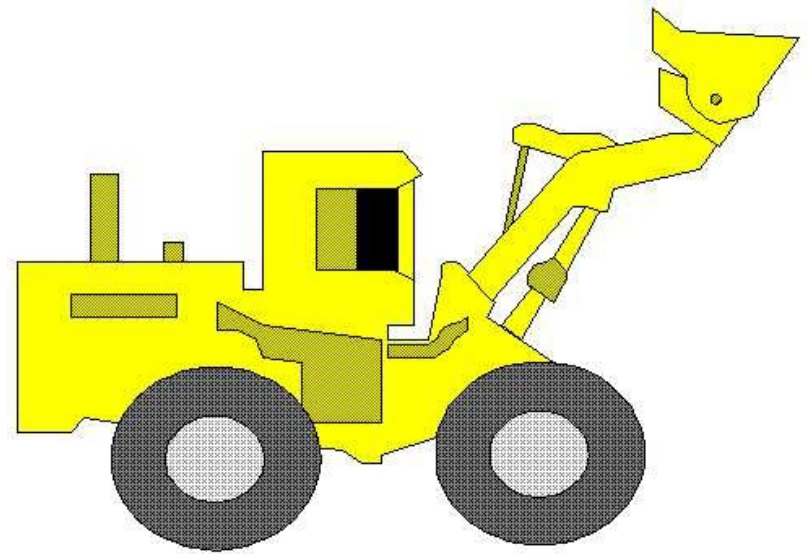
Production Estimation

■ Uses

 – Primarily used for front end loading.

 – Also used for excavating, snow removal, and back filling.

 – It is capable of many other operations with the proper attachments such as; forks, sweeper, snowplow, and multi segmented bucket.

 – Used around rock quarries, when equipped with rock-type tread tires.

 – Used in various tasks, including, stripping overburden, charging hoppers, and carrying materials.

190

Production Estimation

■ Classification
  – Classified according to bucket size.
  – Normal bucket sizes are 2½ and 5 cubic yards.

Production Estimation

- Characteristics
  - Wheeled vehicles characterized by an attachment for lifting and loading.
  - Most common scoop loader attachments are the shovel type bucket and the forklift.
  - Hydraulically operated.
  - Two types of buckets: the general purpose and the multi-segmented bucket.
  - The GP is a one piece bucket made of

Production Estimation

– The multi-segmented bucket is a hinged jaw bucket, commonly referred to as a clamshell.

– The two piece bucket has many capabilities not available to the single piece.

– These include, clamshell, dozer, and scraper operations.

Production Estimation

- Operation
  - Hydraulically operated and powered by a diesel engine.
  - Extremely versatile and capable of many operations.
  - When working in a stockpile, the bucket should be parallel to the ground when loading and raised after penetration.
  - Crowding the material will prevent spilling, and maximize loading.
  - When loading trucks the "V" method should be used.
 - A loader can dig excavations such as defilades and gun emplacements.

Production Estimation

- Production
  - Scoop loaders are affected by numerous factors which must be considered prior to their employment.
  - Among these factors are:
  - Operator skill
  - Extent of prior loosening of material
  - Weight and volume of the material
  - Slope of the operating area
  - Height of material
  - Climatic conditions
  - Management factors.

Production Estimation

- The Marine Corps has 2 scoop loaders in the system.
  - MC1155E
  - 624KR TRAM
  - The 420DV can also be used.
- Estimating using the following formula:
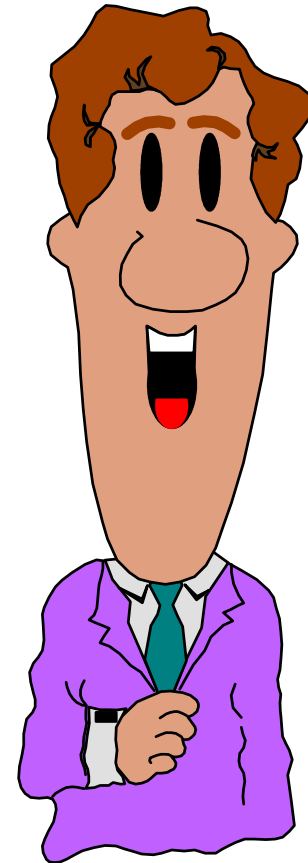
Production Estimation

- Step #1: **Determine Basic (Maximum) Production**
  - $$\frac{\text{Bucket size (CY) x Secs. working/hour}}{\text{Loader cycle time (Secs.)}}$$
    = Basic Production (LCYPH)
  - Note: you can find the seconds you are working per hour by multiplying the minutes you are working per hour by 60.
  - Example:
    $$\frac{2.5 \times 3{,}600}{35} = 257.14 \text{ or } 257 \text{ LCYPH}$$

Production Estimation

- Step #2: **Determine Efficiency Factor (Table 17-5)**
  - Efficiency depends on both job conditions and management conditions.
  - To arrive at an efficiency factor, these conditions must be subjectively evaluated.
  - Job Factors - the physical conditions that affect the production rate of specific jobs, other than the type of material to be handled.

Production Estimation

- *Job Factors to Consider:*
  - Topography and work dimensions, including depth of cut and amount of movement required.
  - Surface and weather conditions, including the season of the year and drainage conditions.
  - Specifications that control handling of work or indicate the operational sequence.
  - Equipment maintenance, and directing personnel.

Production Estimation

- *Management Factors to Consider:*
  - Planning, organizing, and laying out the job; supervising and controlling the operation.
  - Selecting, training, and directing

Production Estimation

Table #17-5   Management Factors

Job Factors	Excellent	Good	Fair	Poor
Excellent	.84	.81	.76	.70
Good	.78	.75	.71	.65
Fair	.72	.69	.65	.60
Poor	.63	.61	.57	.52

Production Estimation

- Step #3: Determine Net Production (LCYPH)
  - To determine the net production in LCYPH, multiply the basis production in LCYPH by the efficiency factor.

Example:

- What is the NET production in LCYPH of a scoop loader with a basic production rate of 257 LCYPH, and an efficiency factor of .71?

257   LCYPH

Production Estimation

- Step #4: Soil Conversion (If Needed)
  - If your requirement, or quantity to be moved, is expressed in either CCY or BCY, you must convert your net production.

Loose

Bank

Compacted
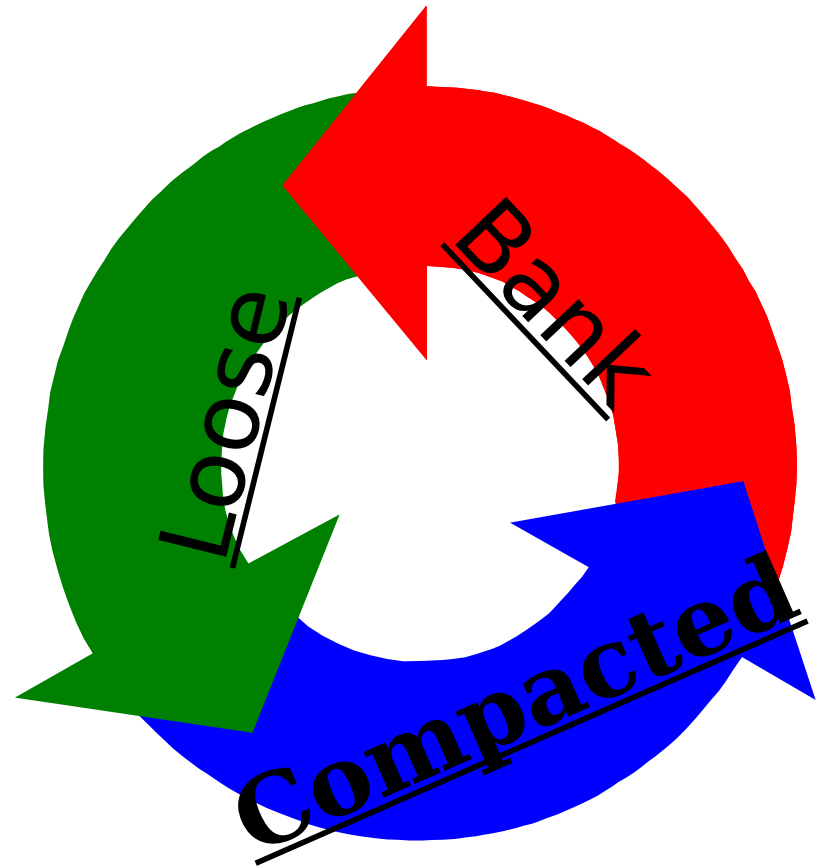
Production Estimation

- Step #5: **Total Time Required (HRS)**
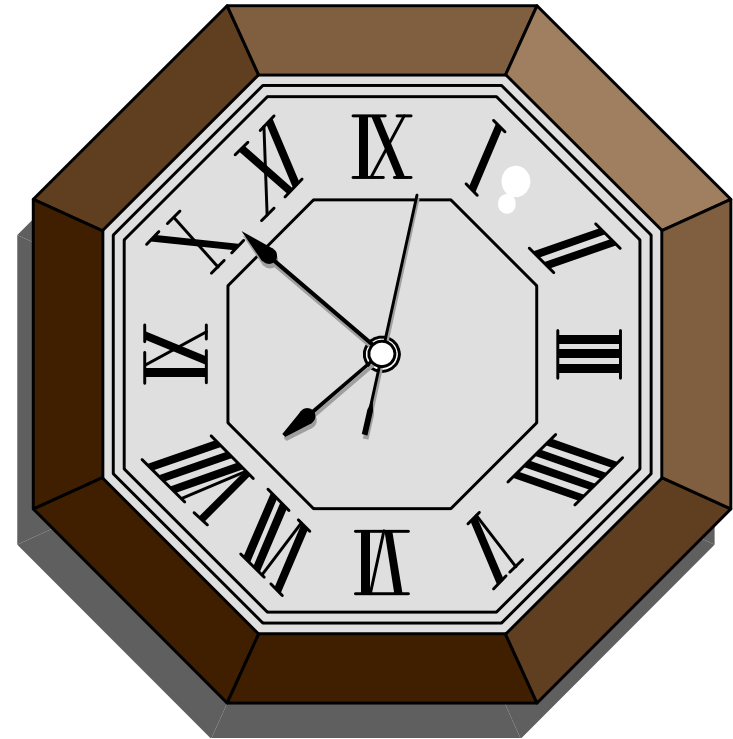 - Determine the total time required to complete the mission.
- <u>   Qty. to be moved</u>

Hrly prod rate x # of loaders =

Total Time (hrs)
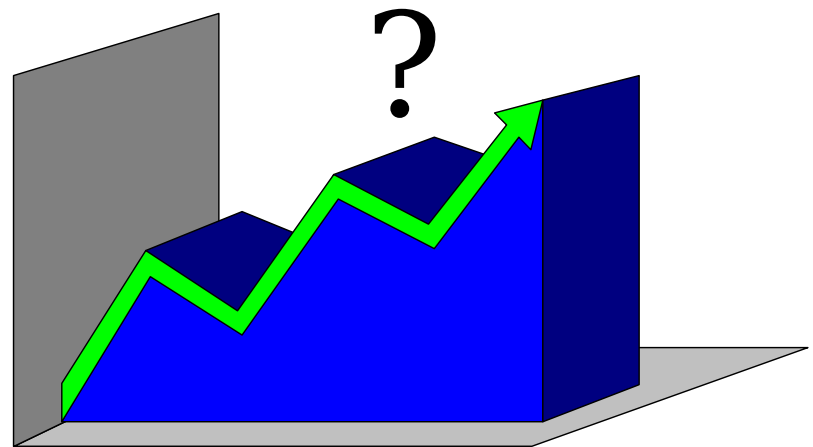
Never round off time

Production Estimation

- Step #6: Total # of Days Required
  - Determine the total # of days the project will take.

$$\frac{\text{\# hrs req}}{\text{\# hrs wk/day}} = \text{\# days}$$
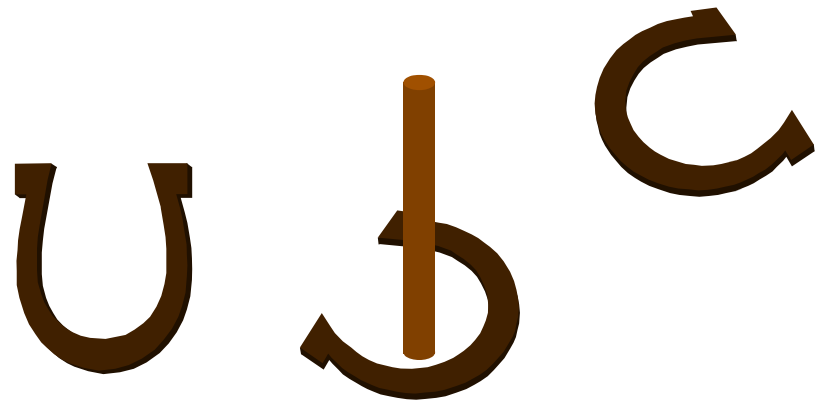
Note: round up to the next full day

Production Estimation

- What have you learned?
- Problem #1

- Problem #2

Solution #1

- 2.5   BUCKET SIZE

x 3,600   SECS/HR Worked

9,000

÷ 120   LOADER CT

75   LCYPH

x .65   EFF FAC

48.75 or 48 LCYPH

x .72 CONV FAC

34.56 or 34 CCYPH

Solution #2

-   1.75   BUCKET SIZE

x 2,700   SECS/HR Worked

  4,725

÷   90   LOADER CT

52.50 or 52 LCYPH

        x .52 EFF FAC

27.04 or 27 LCYPH

Production Estimation

■ Ratio of Loading Units to Hauling Units

 – You need to determine how many loaders is required to keep up with the haul units.
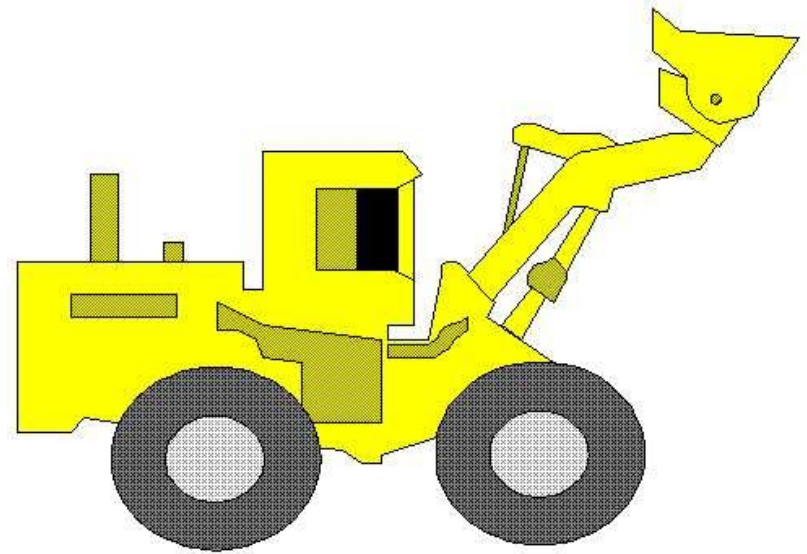
Production Estimation

Use the following formula to figure out how many haul units 1 loader can handle **with no waiting.**

Haul Unit Cycle Time

Load Time (Table #18-5) = # haul units/loader

Note: Round down # of haul units.

Table #18-5 Loading Time

Loading Equipment	621B Struck	621B Heap
1155E	6 min.	8 min.
Tram 644E	5 min.	6 min.

420D IT
    4 in 1 Bucket
    GP Bucket
	
	11 min.
	15 min.
		
		15 min.
		21 min.

ATC - *Clamshell*	15 min.	18 min.

Production Estimation

Notes:
- If the actual load size falls between a struck and a heap load, use the heap load time for the load time.
- These are average fixed times only and are based on an average operator who is familiar with the attachments and equipment operation.
- These times are a basic starting point only.
- Actual fixed times can vary considerably due to varying conditions.
- Timing of several actual cycles is necessary in

Production Estimation

Example:

- How many haul units can 1 Tram handle, if the haul units are hauling 15 CY of material and their cycle time is 14.5 minutes?

14.5

6   =   2.42 or

- Next you need to determine the total number of loading units needed.

- All you would need to do is divide the number of haul

Production Estimation

Total Number of Loading units Needed:

– Use the following formula:

 # HAUL UNITS ÷ HAUL UNIT CYCLE TIME = # LOADING UNITS NEEDED

LOAD TIME (TABLE# 18-5)

Note: Round up # loading units

Production Estimation

- What have you learned?
- Problem #1

- Problem #2

Solution #1

- 8.42   HAUL UNIT CT
  ÷   5   LOAD TIME
  1.68 or 1 HAUL UNIT

Solution # 2

- 　　7　　# Of HAUL UNITS
  ÷ 33　HAUL UNIT CT
  　.21
  x　6　LOAD TIME
  1.27　or 2 LOADING UNITS
  　　　　　　　REQUIRED

216

Production Estimation

- Are there any questions?

- Take a break!

Production Estimation

- Backhoes and Excavators
  - Fast-acting variable-flow hydraulic systems and easy-to-operate controls give excavators the high implement speed and breakout force to excavate trenches, the precision to set pipes, and the capacity to back fill.
  - These vehicles have the mobility to move quickly from job to job.
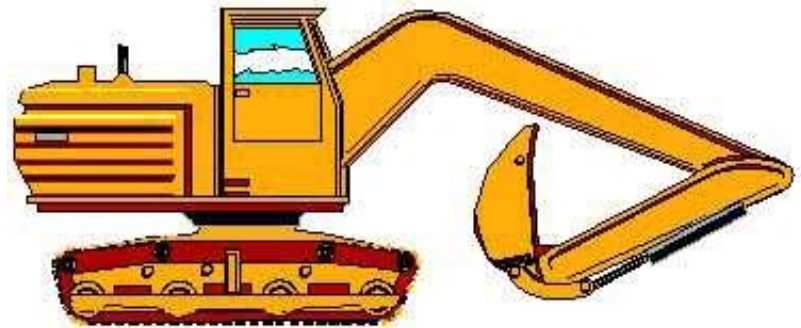
Production Estimation

- **_Use_**
  - Best suited for trench excavating, since it digs well below the unit's wheel or tracks.
  - Large variety of booms, sticks, buckets, and attachments give them versatility to excavate trenches, load trucks, clean ditches, break up old concrete, install outlet pipes, and many others.

Production Estimation

Classification:

- Classified by horsepower.
- The 420DV Backhoe Loader is rated at 88hp

Production Estimation

420DV Backhoe Loader

- Fully hydraulic rough terrain equipped with manually control 4WD
- Will negotiate a max. grade of 35%
- Front bucket is 1 ¼ cy
- Back hoe bucket ¼ cy

Production Estimation

Operation

- Used for sub-ground work.
- A survey should be conducted for underground hazards, as well as surface obstacles.
- It is important that the machine be positioned properly on the job site to gain its greatest effectiveness.
- Before operating level the machine.
- Lower the bucket to the ground.
- Insure the gear shift is in neutral.
- .

Production Estimation

- Production Estimates:
  - Backhoe and excavator production can be determined by using the following steps:
  - Step #1: ***Bucket Size***
    - Determine the size of the bucket that you will use to load with.
  - Use Table #3-2 as before in scraper production.

- Example:
  - You are tasked with digging a

Production Estimation

Step #2: ***Cycles/Hour (CPH)***

– Determine the cycles/hour using the cycle time of the excavator and the **minutes** the operator will be working.

Table #19-6 Depth of Cut

Degree Of Swing	2'	4'	6'	8'	10'	12'	14'
45°	:12	:16	:22	:25	:31	:38	:46
90°	:22	:25	:30	:36	:42	:49	:55

Note: These are average fixed times only and are based on an average operator who is familiar with attachments and equipment operation. Times will vary so it is necessary to time the cycle time to get a more

Production Estimation

- After determining the factors, place them in the formula below:

  Min. worked/hr x 60 sec/min.

  Cycle time in seconds   =
  Cycles/hr

  - Note: Never round off CPH

- Example: If you are operating a 420DV tractor for 50 min/hr, and your cycle time is 35 sec., how many cycles/hr will you operate?

  50 x 60

Production Estimation

Step #3: **Efficiency Factors**
- Efficiency factors depends on both the job factors and management factors.
- Determine the factor as in loader estimations.

Step #4: **Hourly Production Rate (LCYPH)**
- To determine the hourly production rate (LCYPH), take the factors from steps 1 -3 and place them in the formula below:
- Bucket Size x Cycles/hr x Efficiency Factor = LCYPH
- Note: Round down LCYPH

226

Production Estimation

Step #5: **Soil Conversion (If Needed)**

LCYPH x Soil Conv. Fact.

= Converted

CYPH

– Note: Round down CYPH.

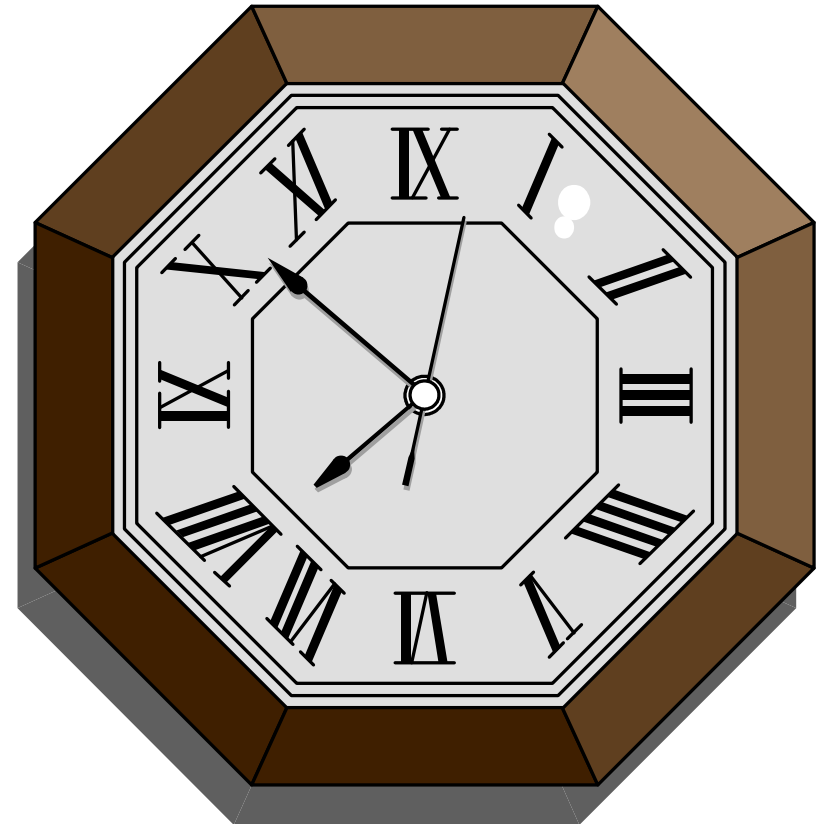Loose → Bank → Compacted

227
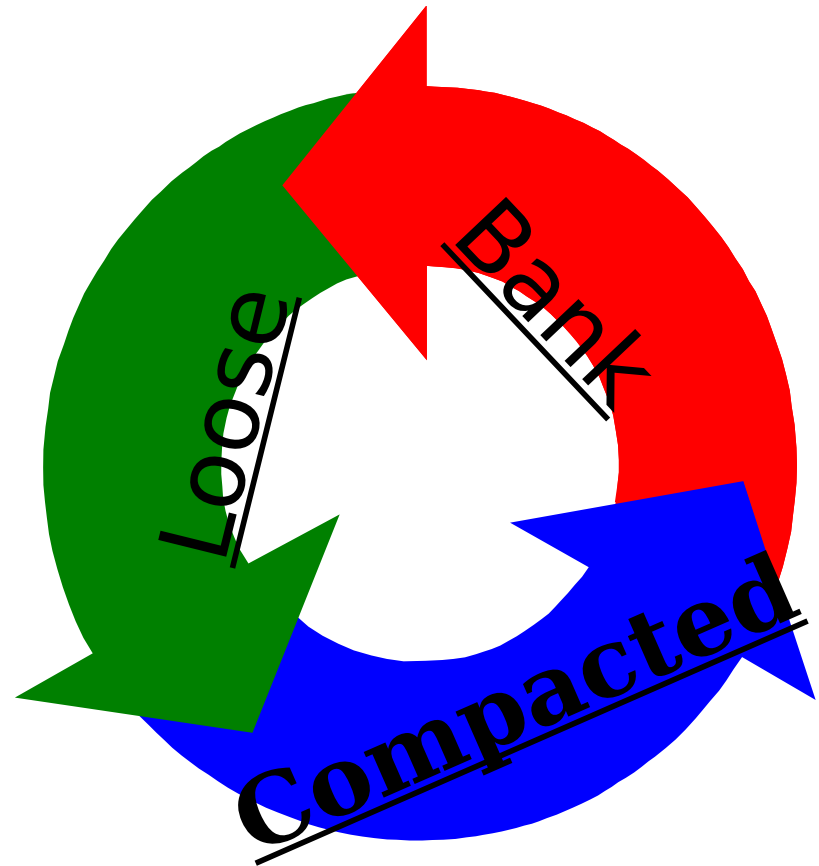
Production Estimation

Step #6: **Total Time Required (HRS)**

– Determine the total time required to complete the mission.

Qty. to be moved

Hrly Prod. Rate x # of equip.=

Total time in hours

Production Estimation

- Step #7: **Total # of Days Required**

  - Determine the total number of days that a project will take.
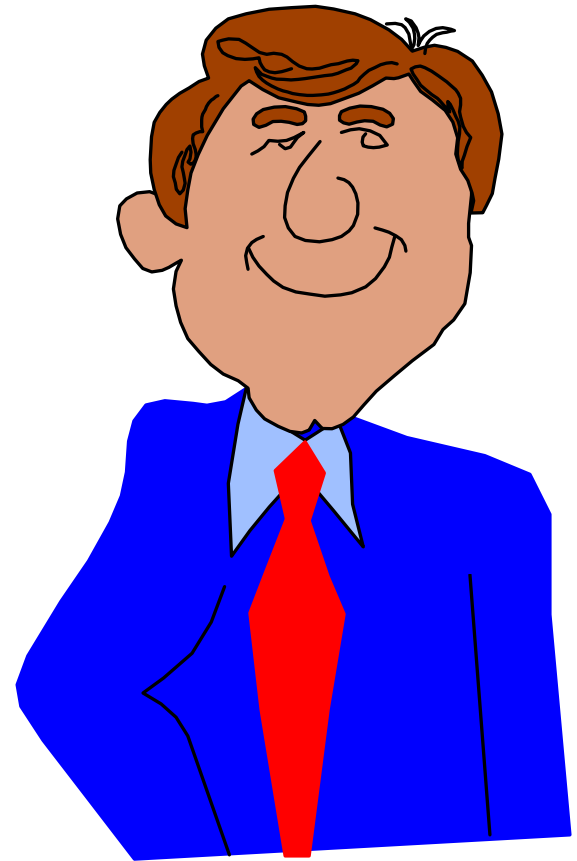
  <u># Hrs. Req.</u>

  \# Hrs. Worked/day

  =

  # of days required

Production Estimation

- What have you learned?
- Problem #1

- Problem #2

Solution # 1

- **.25 Bucket Size**

$\quad$ 30 Min/Hr Worked $\qquad$ 1250 Req Volume

X $\underline{\ \ 60}$ Secs/Min $\qquad$ ÷ $\underline{\ 12}$ Prod

1800 Secs/Hr Worked $\qquad$ 104.17 THR

÷ $\underline{\ 22}$ CT $\qquad\qquad$ ÷ $\underline{\qquad 8}$

$\quad$ Hrs/Day

81.28 CPH $\qquad\qquad$ 13.02 or 14

$\quad$ Days

X $\ \ $.25 Bucket Size

X $\underline{\ \ .60}$ EFF FAC

$\ $ 12.76 or 12 LCYPH

Solution # 2

- 50 MIN/HR Worked   63 REQ VOL

X 60 SEC/HR   ÷ 9 PROD

3,000 SEC/HR Worked   7 THR

÷   45 CT   ÷ 8

HRS/DAY

66.67 CPH   .88 or 1 DAY

X .25 BUCKET SIZE

X .78 EFF FAC

13.52 OR 13 LCYPH

Questions

- Break!

CLAMSHELL PRODUCTION

Production Estimation

- Because of the factors which effect operation of the clamshell, it is difficult to arrive at production rates that are dependable.
  - The difficulty of loading the bucket in different types of soil.
  - The height of the lift.
  - The slow swing required.
  - The method of disposing of the load.
  - The best method is to time the cycle time.

235

Production Estimation

- Example:
  - Determine the production rate and time required to complete the job.

  - Step #1: **Convert Working Minutes/Hour to Working Seconds/Hour.**
  - 50 work min/hr x 60 sec/hr = 3,000 sec/hr
  - Step #2: **Determine the Efficiency Factor:**

Production Estimation

- Step #3: **Production Formula:**

  Bucket size x step #1 x step #2

  45 sec Cycle time (in sec)   = 46 LCYPH

- Step #4: **Soil Conversion (If Needed)**

  – Convert the soil using your soil conversion factors.

- Step #5: **Determine Total Time Required To Complete The Job**

  450 LCY (to be moved)

Production Estimation

■ Step #6: **Total Production Days**

  − 9.78 hrs req ÷ 8 hrs/day = 1.22 or
   2 days

■ What have you learned?
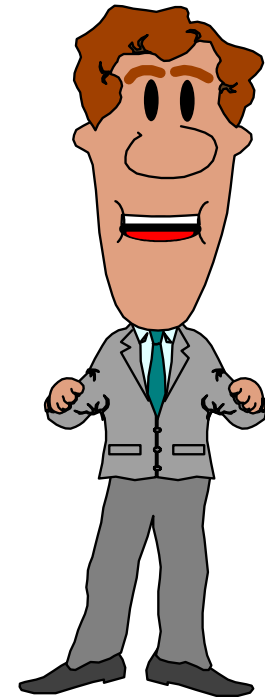
Solution

- 45   MIN/HR Worked   15,000 VOL REQ
  x 60   SECS/HR   ÷   47 PROD
  2,700 SEC/HR   329.79 HRS

  x 1.25 BUCKET SIZE   ÷   7 HRS/DAY
  x   .71 EFF FAC   47.11 or 48 DAYS
  2396.25
  ÷   50 CT
 47.93 or 47 LCYPH

Questions

Production Estimation

Introduction:

- Compaction is the process of mechanically densifying a soil by the application of a moving load.

- No other construction process, applied to natural soils, so drastically affects a soil's properties.

- Although compaction does not effect all soils alike, the advantages gained by compaction have made it a standard and essential part of the horizontal construction process.
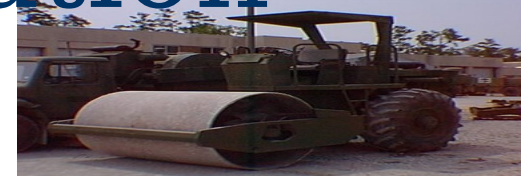
Production Estimation

Uses:

- Compaction equipment is used strictly for mechanical stabilization.
- Proper compaction is the most critical part of construction.
- It allows the structure to meet load bearing requirements.
- In road and airfields, compaction is used from the sub-grade to the final wearing surface.

Production Estimation

Classification:

- Classified by weight, type and method of operation.
- There are basically 2 types of compactors:
- Towed and self-propelled.
- However when classified by method of operation, there are 3 categories:
- Pneumatic, vibratory, and rollers.
- Classification by weight uses the maximum static weight delivered to the

Production Estimation

- **Characteristics:**
  - There are many different types, models, and functions, ranging form hand-held models used for compaction in small areas to larger models used in heavy construction.
  - Some are diesel powered, gasoline powered, or pneumatic powered.

Production Estimation

Operation:
- – Compactors are driven, towed, or manually operated.
- – Because of the basic design of compactors, it is best to operate the power unit behind the compactor.
- – The exception to this is with towed compactors.
- – Extreme caution must be used when compacting on slopes.
- – By nature compactors are slow,ranging from 3-7 mph.

Production Estimation

- **Selection And Testing Of Equipment:**
  - Even though the Marine Corps has one type of compactor (vibratory), the military community has several to choose from.
  - If the job you are working on needs a specific type that the Corps does not have, do not forget that you may be able to temporarily loan one from another service.

Production Estimation

Selection Factors:

- Soil-compacting equipment normally available to the military engineer includes sheepsfoot rollers, tamping-foot, pneumatic-tired rollers, smooth steel-wheel rollers, and vibratory types.

- By knowing the characteristics, capabilities, and limitations of the different types of rollers, a project officer can select the most appropriate type.

- Take a look at Table #20-8 which shows the spectrum of capabilities of each type of roller and the type of compactive effort associated with each roller.

- Note: Use this table only if test strip is

247

Production Estimation

- **Production:**
  - Once you have selected the correct compaction equipment, use the following formula to calculate compactor production in compacted cubic yards per hour.

$$\frac{16.3 \times W \times S \times L \times E}{P} = \text{CCYPH}$$

Production Estimation

$$\frac{16.3 \times W \times S \times L \times E}{P}$$

16.3 = Constant used in formula.

W = Effective width of the roller 6'. The compactor drum is 7' wide, however to eliminate non-compacted strips, each pass should overlap

- S = Compactor speed, in mph. (Table #21-8)
- L = Compacted lift thickness, in inches. (Table #21-8)
- E = Efficiency factor (Table #22-8)
- P = # of passes required (Table #21-8)

Production Estimation

■ Step #1: **Soil Type**

– Production starts with determining what type of soil you are working in.

■ Example:

– You are compacting clay. The operator is working 50 min/hr during the day.

■ Step #2: **Compaction Requirements**

– Using the type of soil you are working get the speed, lift thickness and # of passes from table #21-8.

– S: 3 mph

– L: 8"

Production Estimation

■ Step #3:
Operator/Time Factor

  – Due to the fact an operator cannot physically operate a vibratory compactor for more than 50 min. without a break, it is

■ Step #4:
Production Calculation

16.3 x W x S x L x E

16.3 x 6' x 3 x 8" x .83

7

P

= 278.31 or 278

Production Estimation

Step #5: **Total Hours Required**

– Total to be compacted

$$\frac{1,500 \text{ CCY}}{278 \text{ CCYPH} \times 1 \text{ Comp.}}$$
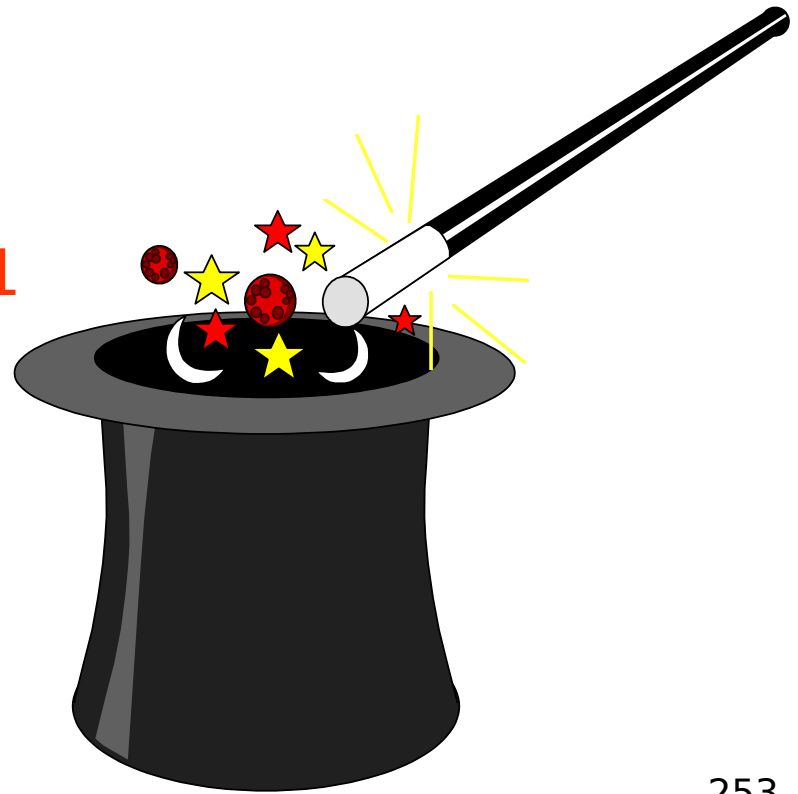
– Hrly prod rate x # comp.

= 5.40 Total hrs required
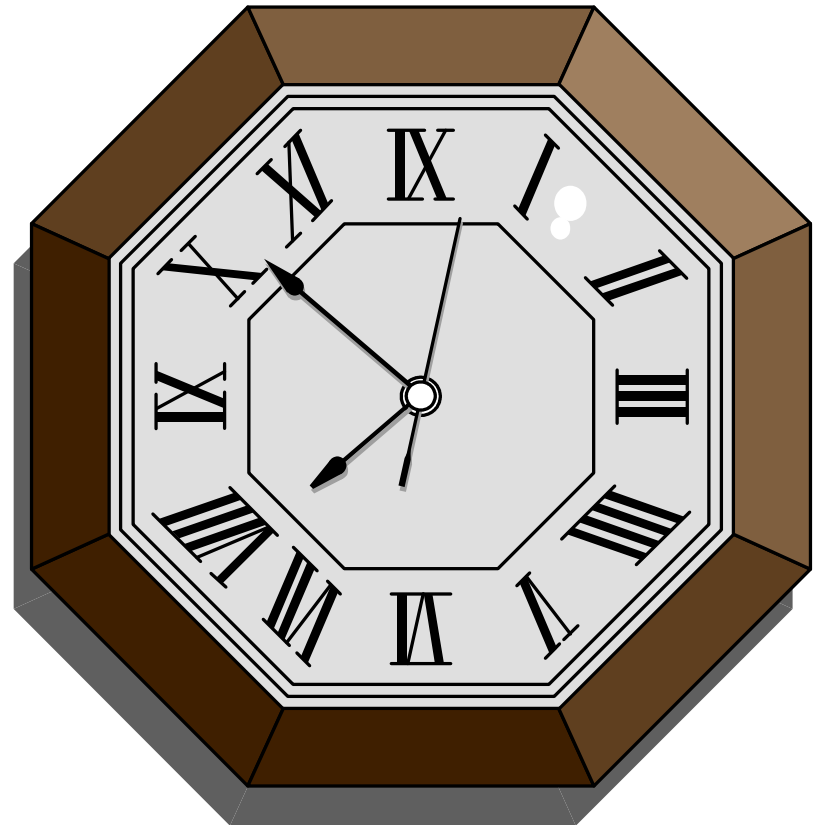
Production Estimation

Step #6: Total Production Days
- Hrs Req ÷ hrs worked/day
- 5.40 ÷   8 = .68 or 1 day
- Note: Round days to next full day.

Production Estimation

- **Ratio of LCYPH to Compactors (If Needed)**
  - Use this step if there is more than one compactor available.

- Example:
  - If you have 36 LCYPH of clay being delivered by 3 621B, how many compactors will it take to keep up with the delivery rate so there will be no slow down in production?
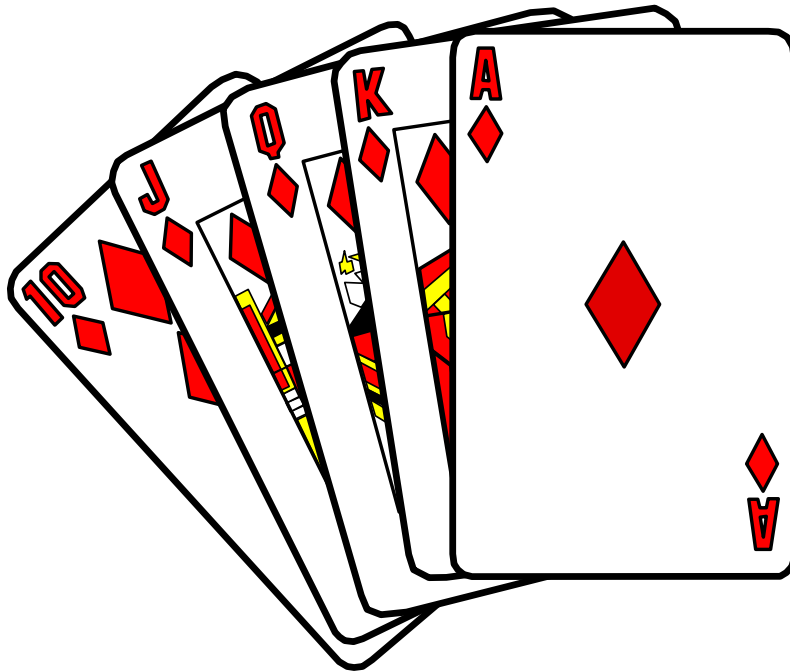
    36 LCYPH x .63 soil conversion

    278 CCYPH   = .08 or 1 compactor

  - Note: Always round up

Production Estimation

- What have you learned?

- Problem #1

- Problem #2

Solution # 1

- 16.3 CONSTANT

    X 6 EFF WIDTH

    X 3 SPEED

    X 8 LIFT

    <u>X.75</u> EFF FAC

1760.40

    <u>÷   14</u> PASSES

125.74 or 125 CCYPH

Solution #2

16.3 CONSTANT   880 SOIL DELV.

X   6 EFF WIDTH   X .63 CONV FAC

X   2 SPEED   554.40

X   6 LIFT   ÷ 176 CCYPH

X .75 EFF FAC   3.15

880.20   or 4 COMP
 REQ

 ÷   5 PASSES

176.04 or

176 CCYPH

Questions

Production Estimation Dump Truck

Production Estimation

Introduction:

– The most common hauling equipment used for military purposes are the 2½, 5, 7 (MK29 MK30),15 and 20 ton trucks.

– The 2½ ton truck is capable of hauling 2½ cubic yards of material.

– The 5 ton 5 cubic yards.

– The 20 ton, used mainly at a quarry, carries 12 cubic yards.

– This will vary according to the type of material being used.

– Materials weighing more than 2,000 lbs./LCY will reduce load size.

Production Estimation

■ **Uses:**

- Primarily used to haul and deliver material.

- Also used to transport troops and equipment in support of the unit mission.

- Equipped with a towing hook and are a tremendous asset for moving equipment and trailers.

- Trucks equipped with winches are valuable for recovery operations.

261

Production Estimation

Classification:

- Classified by weight they carry in tons, by truck volume in cubic yards, or by the heaped capacity in cubic yards.

- For example a 5 ton truck can carry 5.88 cubic yards of loose dry clay weighing 1,700 lbs/LCY but is restricted to the 5 cubic yard capacity.

- Wet clay weighing 3,200 lbs/LCY, for instance would be restricted by the 5 ton capacity.

Production Estimation

Characteristics:

- Characterized by a hydraulic lift cylinder that is used to raise and lower the bed.

- Most trucks are capable of all wheel drive that permit operation in different terrain's.

- The truck becomes top heavy when fully raised, so caution should be taken on side slopes.

- For safest operation, the assistant operator should dismount and act as

263

Production Estimation

Operation:

- – Hydraulically operated and powered by a diesel engine.
- – Haul at the highest speed possible, without speeding.
- – When several trucks are hauling it is essential to maintain proper speeds in order to prevent delays or bottlenecks.
- – Lay out traffic patterns in loading and dumping sites to minimize backing, passing, and cross traffic.
- – Keep trucks clean. The time spent cleaning and oiling truck bodies must be considered in

Production Estimation

■ Operation (Cont.)

– The 900 series dumps cannot raise the bed and move forward at the same time.

– Where as the 800 series MK29 and MK30 dumps can, allowing them to spread the loaded material.

– Dump truck capacities are expressed 2 ways:

– Tons (Use Tables, #23-9, 1-3.1, 1-12.1 or check data plate for load weight.)

– Cubic yards (Use Table 23-9 for CY or call motor transport)

Production Estimation

Table #23-9 Truck Volumes

Type of Truck	Load Capacity in lbs.	Struck Volume in LCY	Heap Volume in LCY
2½ Ton	5,000	Call MT for volume	Call MT for volume
5 Ton	10,000	5 LCY	7.5 LCY
20 Ton	40,000	Call MT for volume	Call MT for volume

- Note: Table information comes from TM 9 2320-260-10 and TM 9 2320-260-10

266

TABLE 1-12.1 Dump Body (MK29 and MK30)

Item	Specification
Struck Payload Capacity – Paved Surface	21,060 lbs (9,561 kg)
Heaped Payload Capacity – Paved Surface	28,000 lbs (12,712 kg)
Struck or Payload Capacity – Cross Country	14,200 lbs (6,447 kg)
Recommended Personnel Capacity	16 (NOTE: Also Refer to paragraph 2-31 for warning information)

NOTE: TABLE 1-3.1 AND 1-12.1 INFORMATION COMES FROM TM 10629-10B

Production Estimation

- **<u>FOR CLASSROOM PURPOSES DO NOT EXCEED 10CY (20,000LBS) CAPACITY!</u>**

- Outside the classroom, note the type of surface you are traveling on, this will change the capacity.

Production Estimation

- Production:
  - Other than scrapers, dump trucks are the primary haul units for earth work in the military inventory.
  - Generally used for hauling distances more than 5,000'.
  - There is ten steps to calculate dump truck production.

Production Estimation

- Step #1: **Actual Soil Weight**
  - To determine the actual soil weight per cubic yard, take the dry soil weight from (Table #2-2).
  - If you are given a moisture content, multiply the weight of the soil dry by the moisture content.
  - This gives you your ASW in pounds.

270

Production Estimation

Step #2: **Cubic Yards Of A Load**

- Remembering that you want to keep the weight of the load under 20,000 lbs., determine how many cubic yards can be hauled without exceeding 20,000 lbs.

- To do this divide 20,000 by the ASW per cubic yard.

  20,000 lbs. (rated capacity)

  ÷2,354 ASW (step #1)

  8.50 CY or no more than 10 CY

- If the resulting figure is over 10 cubic yards, you must go with 10.

- If the resulting figure is less than 10, use that figure in step #3. (note: No more than the

Production Estimation

- Step #3: **Buckets Loaded**
  - Determine the number of bucket loaded that is equal to or less than the figure determined in step #2. Divide that figure , in this case 8.50, by the size of each bucket load (Table #3-2) which for the TRAM is 2.5.

    8.50 CY

    ÷2.5 CY (bucket size from table #3-2)

    3.40 or 3 buckets

Production Estimation

■ Step #4: **Actual Load Size Or Volume**

 – To determine the volume of the load, take the answer from step #3, 1 bucket/load, and multiply by the bucket size (2.5 for a TRAM).

 3   # of bucket/load

 x 2.5   TRAM bucket size

 7.5   Actual Load Size (ALS)

 – Note: Never round off load size or

Production Estimation

- Step #5: **Load Weight**
  - Always try to keep your soil weight under 10,000 lbs.
  - Use Table #2-2 to determine you load weight.

    2,354 ASW (from step #1)

    x 7.5   ALS (from step #4)

    17,655 Load Weight (LW)
  - Now you know your load weight. You can now calculate your cycle time.

Production Estimation

- Step #6: **Cycle Time**
  - Use Table #24-9 to get your travel speed.
  - The table is for classroom purposes only.
  - To figure cycle time you need to determine the travel time (TT).
  - To get TT divide the distance in feet by your travel speed (TS) multiplied by 88.
  - Do this for the haul and return to get your total cycle time.
  - Note: 88 is the conversion factor to change the speed in mph to feet per

Production Estimation

- Haul:
  - $\dfrac{\text{Distance in feet}}{\text{TS x 88}}$ = Haul Time (HT)

- Return:
  - $\dfrac{\text{Distance in feet}}{\text{TS x 88}}$ = Return Time (RT)

- HT + RT + 2 min. fixed time = CT

- Note: Use 2 min. as a constant fixed time for dump trucks in the [276]

Production Estimation

- Example:

  Haul:

  <u>7,500'</u>

  35 TS x 88 = 2.44 HT

  Return:

  <u>8,200'</u>

  50 TS x 88 = 1.86 RT

  2.44 HT + 1.86 RT + 2 min = 6.30 CT

  - Note: round off cycle time 2 places after the decimal point.

Production Estimation

- Step #7: **Trips Per Hour**
  - To determine trips per hour (TPH), divide the working minutes per hour by the cycle time.

    Working Min./Hr

    Cycle Time   =   Trips/Hr (TPH)

- Example:
  - How many trips per hour can a dump truck make during a 60 min. work hour and a cycle time of 6.30 min/trip?

    60 min/hr

    6.30 CT   =   9.52 TPH
  - Note: Never round off TPH

Production Estimation

Step #8: **Hourly Production Rate**

- To determine the hourly production rate you must know the size of the load (in LCY), the number of trips per hour, and the efficiency of the operator and equipment (Table #7-2 this is the same table used in scraper production).
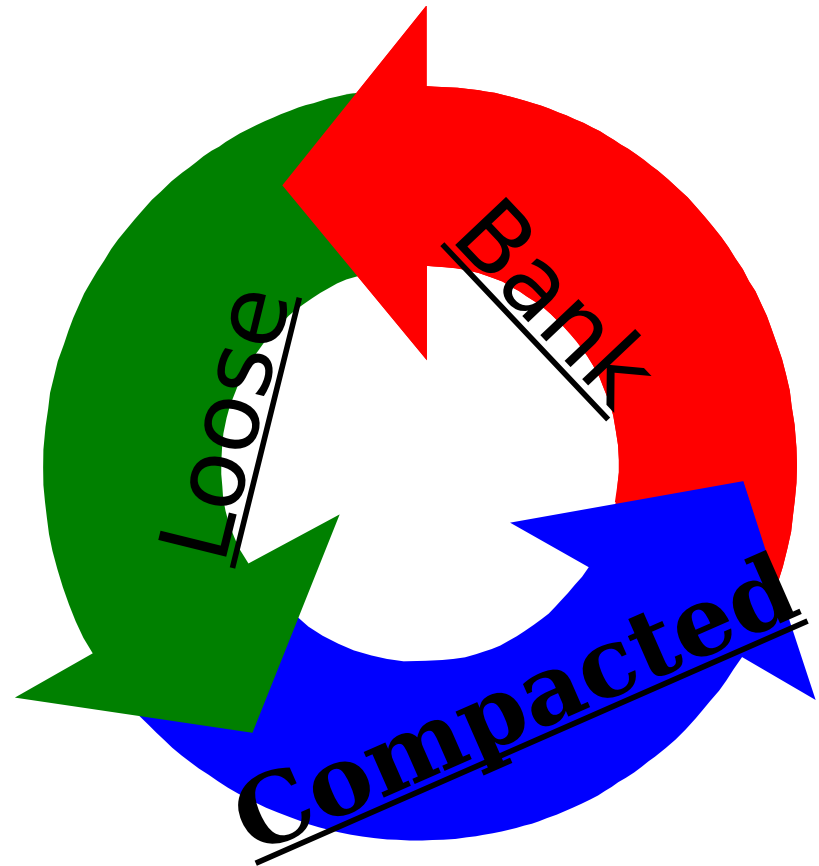
TPH x ALS x Efficiency Factor = LCYPH

Example:

- What is the hourly production rate of a dump truck with an average operator, working a day shift, making 9.52 TPH, with a load of 7.5 LCY?

9.52 TPH x 7.5 ALS x .60 Eff. Fact. = 142.84 or

42   LCYPH

Production Estimation

- Step #9: **Soil Conversion (If Needed)**
  - Convert you type of soil from one state to the other depending on what the job requires.

Production Estimation

- Step #10: **Ratio Of Trucks To Scoop Loader.**
  - Determine the number of trucks to keep 1 scoop loader moving with no down time.
  - Step #1: **Loads/hr**

    Loader Production (LCYPH)   (step# 1to3 of loader prod.)

     Trucks ALS (LCY/load)   =   Loads/Hr. Do not round off
  - Step #2: **Loading Time Per Truck**

    Min worked/hr

      Loads/hr   =   Loading Time/Truck (min)
  - Step #3: **Formulate**

      Truck CT (from step 6)

                        + 1 = Trucks Req.

Production Estimation

Example:

- The TRAM is putting out 150 LCYPH and you are using a 7 ton w/ 2.5 LCY/load. You are working 50 min/hr.
- Step #1

  150 LCYPH

  2.5 ALS   = 60 Loads/hr
- Step #2

  50 Min. worked/hr

  60 Loads/hr   = .83 Loading time/truck
- Step #3

  6.30 Truck CT

  .83   Loading time/truck (min) = 7.59 +1 = 8.59 or 8   Trucks Required

Production Estimation

- Step #11: **Total Hours Required to Complete Mission**
  - To determine the total time required to complete the mission, you must know the total volume to be moved, the hourly production rate, and the number of trucks you will use on the job.

    <u>1,900</u> CCY required

    10   CCYPH x 3 Dump Trucks = 63.33 Hrs.

  - Note: Never round off time.

Production Estimation
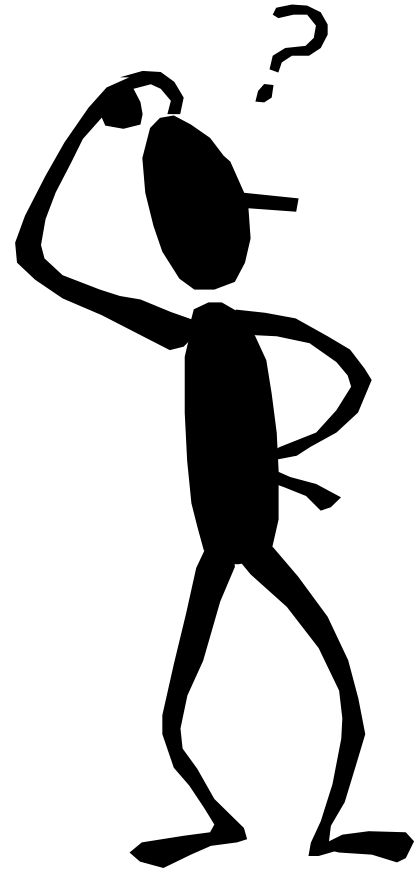
- Step #12: **Total Production Days**
  - To get the total days, divide total time required by the hours worked per day.
  - Example:

    <u>63.33</u> Hrs. Required

    8   Hrs./Day   = 7.92 or 8 Total Days

Production Estimation

■ What have you learned?

Solution

```
   2,000   DRY CLAY
x    1.08   MOISTURE
   2,160   ASW


  20,000   MAX LOAD SIZE
÷  2,160   ASW
   9.26   CY OF THE LOAD


   9.26   CY OF THE LOAD
÷    2.5   BUCKET SIZE
   3.70
   OR 3   BUCKETS LOADED
x    2.5   ALS
   7.5   ALS
```

Solution

2,160 ASW
x   7.5 ALS
16,200 LW

6,600 HD
35 X 88   = 2.14 HAUL TIME (HT)

6,600 RD
50 X 88   = 1.50 RETURN TIME (RT)

  2.14   +   1.50   +   2.00   =   5.64
HAUL TIME   RETURN TIME   FIXED TIME   CYCLE TIME

Solution

```
        60   MIN/HR
÷    5.64   CT
    10.64   TPH


    10.64   TPH
     7.5   ALS
x        .6   EF
    47.88
   OR 47    LCYPH


        47   LCYPH
x        .63   CONV FACTOR
    29.31
   OR 29    CCYPH
```

Solution

5.64 TCT
÷   .50 LCT
11.28
+   1.00
12.28
OR 12 TRUCKS REQUIRED

170,000   FILL REQUIRED
÷ (29 x 12)
488.51 THR

488.51
÷   10
48.85
OR 49 DAYS REQUIRED

Questions?

- Break!

SUMMARY